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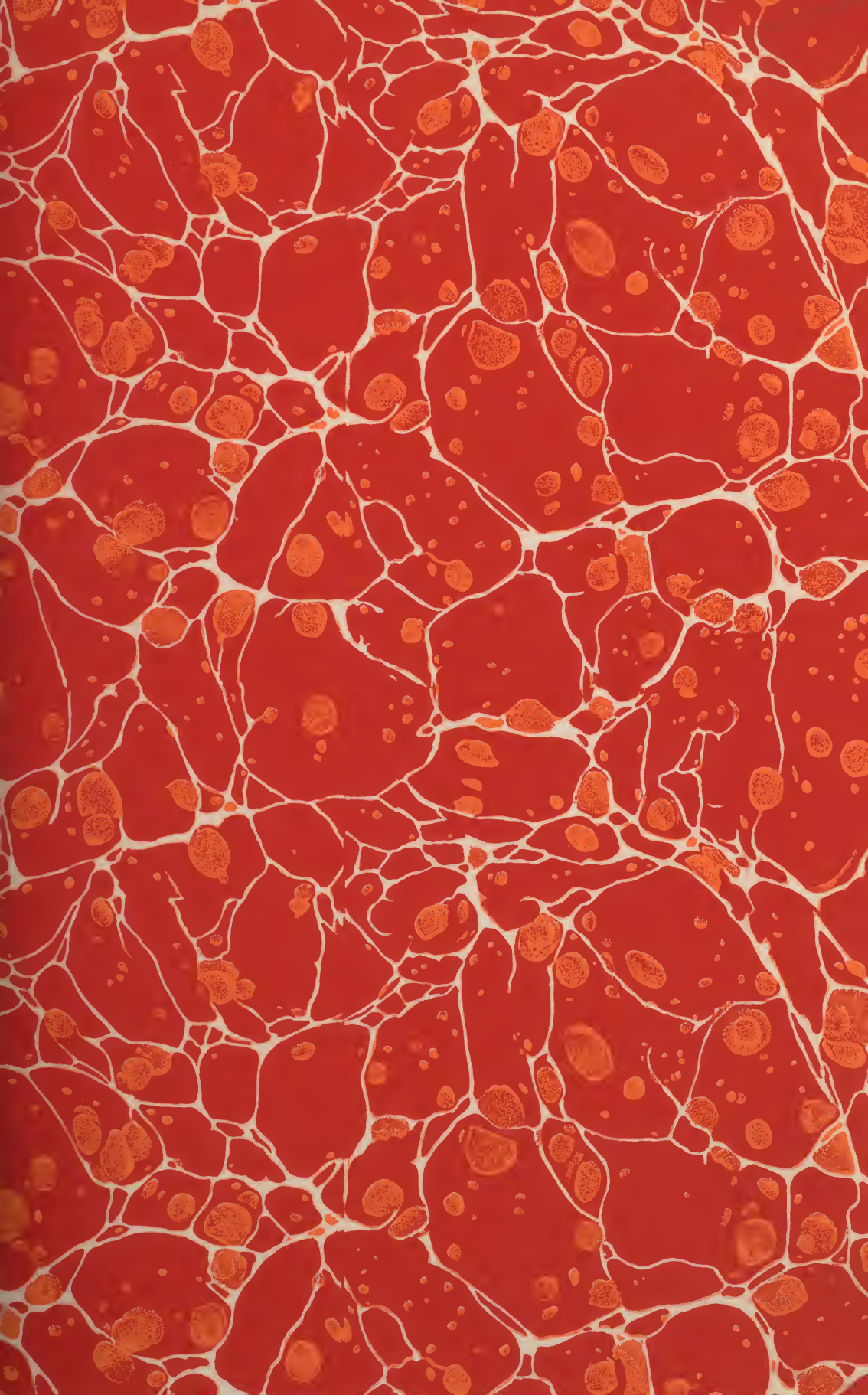
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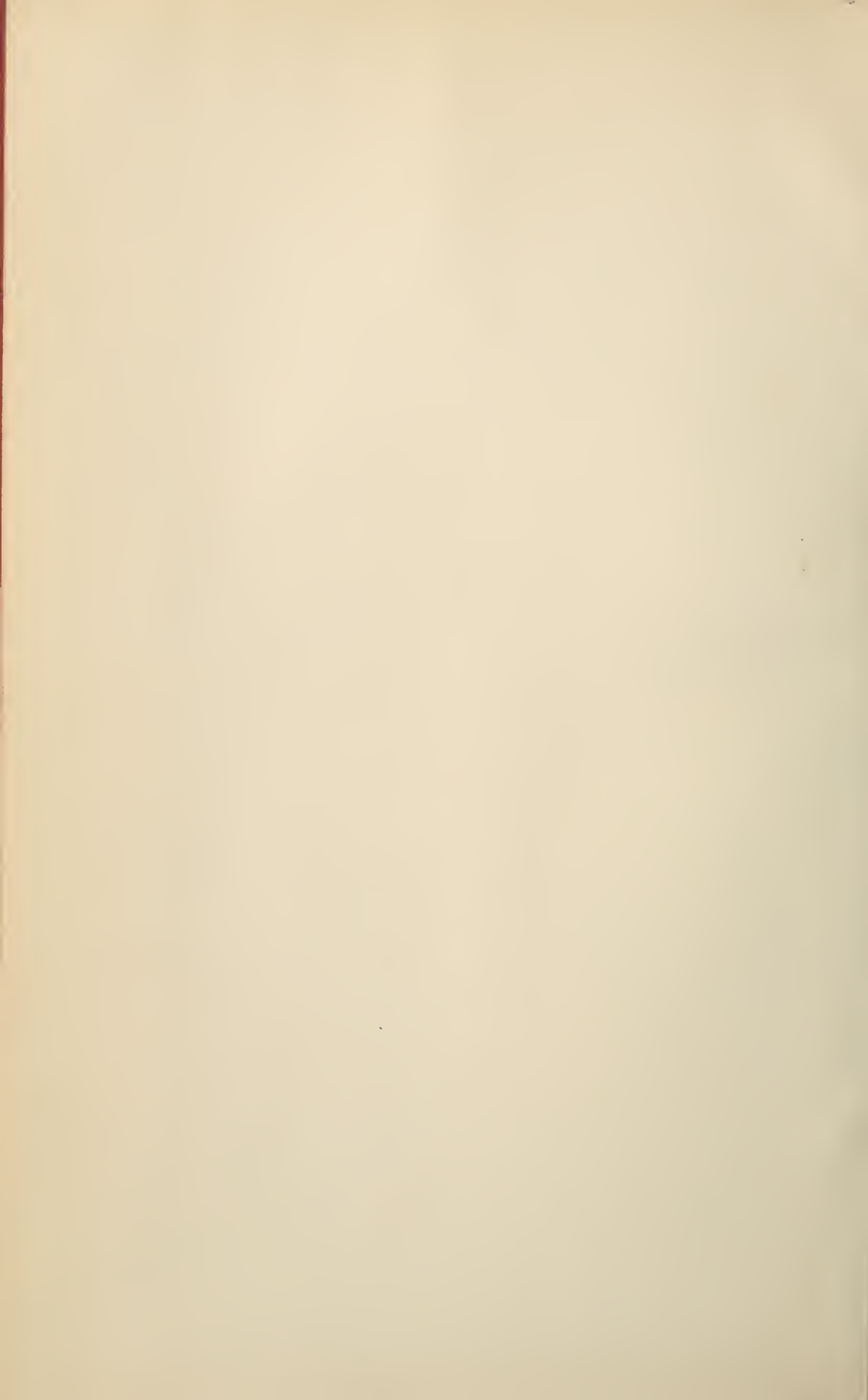
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THE
INTERNATIONAL ENCYCLOPÆDIA
OF
SURGERY.
VOL. II.



THE
INTERNATIONAL ENCYCLOPÆDIA
OF
SURGERY

A SYSTEMATIC TREATISE
ON THE
THEORY AND PRACTICE OF SURGERY
BY
AUTHORS OF VARIOUS NATIONS

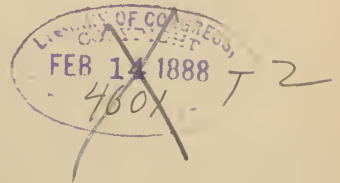
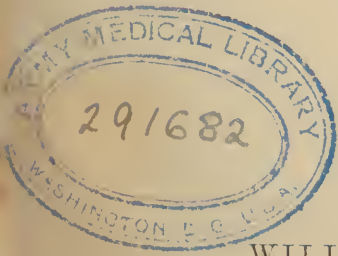
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PENNSYLVANIA HOSPITAL, ETC.

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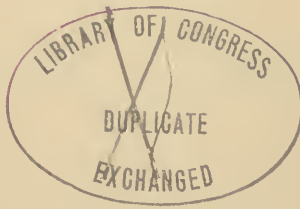
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THE INTERNATIONAL ENCYCLOPÆDIA OF SURGERY.

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POISONED WOUNDS. By JOHN H. PACKARD, M.D., Surgeon to the Pennsylvania Hospital and to St. Joseph's Hospital, Philadelphia. Page 85.

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ALPHABETICAL LIST OF AUTHORS.

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By

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VENEREAL DISEASES: THE SIMPLE VENEREAL ULCER OR CHANCROID.

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VENEREAL DISEASES: BUBON D'EMBLEE, VENEREAL WARTS OR VEGETATIONS, PSEUDO-VENEREAL AFFECTIONS, VENEREAL DISEASES IN THE LOWER ANIMALS.

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INJURIES OF BLOODVESSELS.

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SURGICAL DISEASES OF THE VASCULAR SYSTEM.

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THE INTERNATIONAL ENCYCLOPÆDIA OF SURGERY.

CONTUSIONS.

BY

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A CONTUSION may be defined to be a laceration of the subcutaneous tissues without solution of continuity of the skin. When the force which produces the contusion divides the skin, the injury becomes what is known as a *contused wound*. If the cuticle alone is implicated, the injury is an *abrasion*. But while the skin is not primarily broken in contusions, it is frequently so injured that its vitality is destroyed, and that sloughing takes place subsequently.

CAUSES OF CONTUSIONS.

Contusions are caused in a variety of ways: by blows, falls, or violent pressure. The force which produces a contusion may be *direct*, as is seen in the case of the "black eye" which follows a blow of the fist, or in that of the laceration of the muscles of a limb produced by contact with a partially spent cannon ball; or it may be *indirect*, as in the case of a fall upon the hand, when the arm is extended, causing contusion of the shoulder; or in that of a fall from a height, the patient striking upon his buttocks, producing injury of the skull, with concussion and contusion of the brain. We see examples of contusion from severe pressure, in railway injuries, in those caused by machinery in rapid motion, and in those which result from the passage of the wheels of a vehicle over the body. A good illustration of contusion by pressure is sometimes observed, after difficult parturition, in the bruised scalp of the infant, and in the swollen vagina and vulva of the mother—the injury in some cases terminating in sloughing and the formation of vesico-vaginal or recto-vaginal fistulae.

DEGREES OF CONTUSION.

The *degree* of a contusion may vary from a slight bruise or pinch of the skin and subcutaneous fascia to a complete crushing and disintegration of a part, according to the amount of violence employed, the resistance of the tissues, and the health of the individual injured. Persons whose blood has been impoverished by long-wasting disease are easily bruised. Fat, anæmic women, young or old, especially if bed-ridden for any length of time, are the subjects of frequent *ecchymoses* produced by the most trifling causes—such as turning over in bed, if the mattress is hard or uneven; or the grasp of the nurse's hand, in assisting them to move. These bruised spots, or *ecchymoses*, appear chiefly on the hips, back, and arms; but may come on any part of the body. Individuals who are subjects of the scorbutic or of the hemorrhagic diathesis, are peculiarly liable to *ecchymosis*; but purpuric spots and patches must not be confounded with the discoloration of a bruise. The term *bruise*, or *ecchymosis*, is applied to cases in which the contusion is slight, and in which but a small quantity of blood and blood-stained fluid is effused into the subcutaneous tissue; a contusion which is indicated by the familiar bluish-black discoloration which follows. If the contusion is more severe, involving deeper structures, laceration of larger vessels occurs, and a greater quantity of blood is poured out. In these cases the discoloration which attends the extravasation may not be seen for several days, as it takes some time for the effused blood to make its way through the tissues to the surface. The discoloration may also appear at a distance from the site of injury. When the extravasated blood is coagulated, it is known as a *thrombus*; if it is collected into a cavity and remains fluid, it is called a *hematoma*. The more vascular and yielding the part—other things being equal—the greater is the hemorrhage. The blood which escapes from the bloodvessels and is confined in the tissues, coagulates over and compresses the lacerated vessels, and in this way, to a great extent, the bleeding is stopped.

When the contusion is of the highest degree, and the part is completely crushed and disorganized, it is said by some authors to be *pulped*. In these extensive injuries the skin may also be involved, and show some signs of lesion; but frequently its great strength and elasticity enable it to escape unhurt. The skull may be crushed into numberless fragments, and the brain may be lacerated by a portion of a shell, and yet the scalp may remain apparently uninjured; or the wheel of a carriage may pass over a limb, breaking the bones and reducing the soft parts to a pulp, while the skin continues unbroken. When a contusion is severe, the muscles and other soft parts being broken up, a large bloodvessel may be ruptured, and hemorrhage, even to the extent of causing fatal syncope, may ensue; or the contusion and disintegration may be followed by rapid sloughing, or even by acute gangrene of the parts. In such cases the bloodvessels sometimes appear at first to have escaped injury; but they speedily succumb to the mortification which follows. In some instances there are lacerations of internal organs, such as the lungs, liver, spleen, bladder, brain, or spinal cord, leading perhaps to extravasation of blood into a serous cavity.

If the case is one of simple bruise, or *ecchymosis*, the bleeding takes place in the areolar tissue just below the skin, and usually in small quantity; but Mr. Erichsen has related a case in which a school-boy was beaten to death by his teacher, and in which, at the post-mortem examination, the subcutaneous areolar tissue of the arms and legs was found separated from the fascia below, the space between being filled with extravasated blood. Death in this instance was attributed principally to the interstitial hemorrhage.

SYMPTOMS OF CONTUSIONS.

The *symptoms* which generally follow contusions are shock, pain, swelling, and discoloration.

SHOCK.—Unless the individual has some unusual nervous susceptibility, *shock* is rarely present in cases of slight contusion; and even in those of a more serious character, it is not generally as severe as the gravity of the accident would lead us to expect. If some of the internal viscera, however, are involved, the shock may be at once fatal, or may become so after a feeble attempt at reaction.

In the case of a soldier whom I saw, struck by a Minié ball on the metal buckle of his sword-belt, the injury producing contusion of the front wall of the belly, with violent concussion of the abdominal contents, but without any appreciable lesion of the internal viscera, death from shock followed in a few moments.

Contusion of the testicle is attended by severe shock and by nausea and vomiting, with great loss of muscular power, and with a tendency to fainting.

PAIN.—The effect first experienced from a contusion is commonly more or less paralysis of motion and sensation. A violent blow upon the leg may cause the recipient to fall from sudden loss of muscular power. The numbness or dead feeling which first follows the blow is soon succeeded by heavy, aching *pain*, severe and lasting according to the violence of the injury and the nature of the part struck. If the trunk of a nerve be involved in the injury, the pain is burning and tingling, and may extend to the terminal branches of the nerve. If the soft parts alone are contused, the pain soon disappears, and, if the injury is slight, is relieved by rubbing with the hand. But when fibrous tissue, such as that found about a joint or a superficial bone, is involved, the part remains tender and intolerant of any manipulation or pressure for a long time.

SWELLING occurs soon after the injury. At first the parts may be condensed or compressed by the blow, as is sometimes seen in injuries of the scalp, where, the skin and cellular tissue being compressed, and the vessels paralyzed at the seat of injury, swelling takes place in the parts around. This condition may easily be mistaken for fracture with depression of the bone, or, even if fracture be present, the depression may be thought to be greater than it really is. This compressed state of the soft parts, when present, slowly passes off, and the part then becomes swollen from the effusion of blood which escapes from the ruptured vessels, and from the exudation of serum and fibrin which are poured out from the bloodvessels of the contused parts. It is to the latter cause that the swelling of contusion is principally due. The "bump" produced on a child's head by a blow, and the welts on an animal's skin caused by the lash of a whip, are the result of exudation of bloody serum poured out from the vessels of the contused part, the violence inflicted causing rapid determination of blood to the site of injury, and sudden distension and elongation of the bloodvessels. The extent of the swelling will depend upon the size of the injured vessels, the violence of the lesion, and the looseness or firmness of the tissue involved. In the eyelids, scrotum, penis, and labia, the swelling is generally very great.

The extravasation comes for the most part from the veins, the walls of which are more easily injured than those of the arteries. When an artery of any size is lacerated, blood is poured out rapidly, forming a spurious aneurism,

with distinct pulsation. The blood accumulation thus formed may, according to the character of the tissues in which it is placed, be circumscribed, or spread over a large surface, and may, after a time, settle by gravity to the most dependent position.

Medico-legal Import of Extravasation and Ecchymosis.—When a blow or other injury is inflicted on a body after death, venous blood in small quantities may be effused under or upon the skin, but not into the substance of the *cutis vera*. When the extravasation is extensive, or the skin thickened, having greater firmness and tenacity from infiltration of blood, it is fair to conclude that the injury has been received before death. This condition of the true skin, while not necessarily present in every case of contusion in the living, cannot be produced by blows upon the dead body. An ecchymosis following an injury received during life, may not make its appearance until some hours after death; or a small bruised patch, seen during life, may increase in size after death. A contusion received some hours or days before death, may often be recognized as an injury of some duration by the changes which have taken place in its color, the borders of the ecchymosed patch having become lighter and faded, and portions of the bruise looking greenish or yellow. It is well to recollect, in medico-legal investigations, that a severe blow is not always followed by visible discoloration. The injury may have been sufficient to cause death, and yet no mark of violence may be seen on the skin or subjacent tissues. It should also be remembered that a very slight contusion, causing little or no pain, may produce extensive ecchymosis in purpuric individuals, or in “bleeders,” or in persons who have a large quantity of subcutaneous fat.

DISCOLORATION often makes its appearance in a few moments after the injury has been inflicted. Sometimes, however, several days pass before it is seen, and when this is the case it indicates a deep-seated lesion. After fractures, discoloration is frequently not seen until two or three days have elapsed. The ecchymosis may reach its full extent in a few minutes, extravasation of blood and exudation of bloody serum ceasing soon after the blow; or it may go on for several days, gradually extending for some distance under the skin. The discoloration at first may be black, or a deep purplish-blue, or, in some cases, pink or crimson. Blackness usually indicates a severe injury and extravasation of pure blood; various shades of purple or blue are produced when blood is mixed in different proportions with blood-stained serum; a pink or crimson hue shows that the ecchymosis is superficial, and that oxygen from the atmosphere is admitted through the thin epidermis or mucous covering of the part. We see examples of the latter condition in ecchymosis of the eye, where the crimson color contrasts strongly with the deep blue or black bruise of the lids and surrounding soft parts, after injuries in that region; and in the pink or red color of a superficial blood-blister just below the epidermis; when the contusion is more deeply seated, the blister is black. The discoloration changes in ordinary cases after the lapse of one or two days. Gradually it becomes lighter, changing from black, or blue, to an olive-brown; then to a greenish-yellow; and finally to a lemon hue, after which it disappears. These changes in color are probably due to the influence of air and light upon the extravasated material, as in deeper parts—among the muscles for instance—the shade of color is always that of either venous or arterial blood, or of a mixture of these fluids.

Vesicles or blebs filled with bloody serum not unfrequently follow bruises, and, when the discoloration is black or purple, the appearance of the part resembles that of gangrene. The phlyctenæ of mortification, however, are filled with putrid serum; and as the scarf skin is detached for some distance around

the bleb, the serum can be made, by slight pressure, to move about from one point to another. This is not the case with the vesicles of a bruise. The latter are also attended by pain and heat; those of gangrene by an absence of both heat and sensibility. In gangrene an offensive odor, and crepitation from the presence of gases, may also be observed.

ABSORPTION OR ORGANIZATION OF EXTRAVASATED SUBSTANCES.

When the contusion is simple, and not followed by much inflammation, the extravasated fluids are soon *absorbed*, and the parts restored so fully to their original healthy condition that no evidence of injury can be found. This is sometimes the case in the contusions which attend severe fractures, the absorbents gradually taking up the deposit, which eventually is carried out of the body by some of its emunctories. The fluid portion of the extravasation is rapidly absorbed; the coagulated portion more slowly. When, however, the injury is severe; or when it occurs in an individual whose health is impaired by some vice of constitution, the effusion of blood and bloody serum may remain for many weeks, or even months, unchanged. It may continue liquid, or may become solid, or may be partly solid and partly fluid. When the laceration is severe, and blood collects in a cavity, the effusion is called, as has been said, a blood tumor or hæmatoma. The walls of this cavity are formed of blood-clot, and condensed, cellular and other tissue. The tumor is thus circumscribed, having its boundaries well defined. We find such accumulations frequently accompanying contusions of the back, nates, and loins, and in other places where the cellular tissue is abundant. When the blood remains for some time unabsorbed, its presence causes adhesive inflammation, which closes the cells of the tissues around the deposit, and a thin layer of plastic matter is thrown out, which becomes organized and which is eventually lined by a layer of secreting cells. The walls of an old hæmatoma look very much like those of a thin-walled cyst or abscess. The diagnosis between blood tumor and abscess, or malignant disease, is not always easy. The affections may usually be distinguished by the history of the case—the hæmatoma coming on soon after contusion—and by the absence of signs of inflammation and engorgement of the parts around the swelling; and, if necessary, by use of the exploring needle and by microscopic examination of the contents of the swelling.

The question whether blood extravasated in a contusion can be *organized* and become the nidus of a new growth, is an important and interesting one. John Hunter¹ declared that he had reason “to believe that the coagulum has the power, under necessary circumstances, to form vessels in and of itself,” and this theory was practically accepted by Sir Astley Cooper and others of that day. Sir James Paget² says: “There is sufficient reason to believe that blood extravasated in a contusion may be organized;” but he adds, “Nevertheless, it is not probable that this organizing of blood is frequent after contusions; and the more exact the researches that are made, the less reason is there found to adopt the belief that blood extravasated in a contusion can become a tumor of any kind.” Rindfleisch says that the process of organization is effected by leucocytes which come from the tissues in the neighborhood of the clot, and not from the clot itself. It seems not at all improbable that the new growth has its origin, not in the clot, but in some plastic deposit left there by inflammation originally set up by the force which

¹ Treatise on the Blood, etc. Works (edited by J. F. Palmer), vol. iii. p. 119. London, 1835.

² Article on Contusions. Holmes's System of Surgery, Second edition, vol. i. p. 623. London, 1869.

produced the contusion; or possibly caused by the mere presence of the blood itself. Whatever the process may be—and it is certainly an obscure one—the fact that tumors, benign and malignant, follow severe contusions, is in accordance with the experience of many observant practitioners of surgery.

PROGNOSIS OF CONTUSIONS.

Unless the parts involved in contusions are important to life, or the injury is extensive, or the patient old or unhealthy, recovery usually takes place, and the parts are completely restored to their original condition. The prognosis, however, is not always favorable. If an internal organ, such as the liver, kidney, or bowel, be involved, the result may be quickly fatal. Contusion of the prostate gland, in the operation for stone in the bladder, is not an uncommon cause of death after lithotomy and lithotripsy. In old people, or those of unsound health, a bruise may be followed by inflammation, suppuration, and sloughing, attended by great suffering and danger; or the effused blood may become decomposed, and the case end in septicæmia from absorption of the poisonous fluids and gases thus generated.

When the injury is severe and the ecchymosis extensive, contusion frequently terminates in *abscess*. The blood acts as a foreign body, leading to irritation and inflammation, which continue until suppuration, ulceration, and not unfrequently sloughing, take place. The discharge at first consists of decomposed blood, mixed with pus and the *débris* of tissue, but after a short time becomes like that of an ordinary acute abscess. Suppuration is most apt to follow contusions in feeble and unhealthy individuals, or in cases in which a breach of continuity in the skin has allowed the admission of air to the blood deposit. In persons whose constitution has been impaired by intemperance, scurvy, anæmia, or other cause, severe bruises are apt to terminate in suppuration of a diffuse character.

If, together with the contusion of the superficial tissues, some larger joint be involved, bloodvessels or nerves be ruptured, or bones be broken, the prognosis, is, of course, unfavorable. Contusions involving the periosteum are sometimes followed by permanent induration and thickening of that membrane, attended by great tenderness and pain. Sometimes the site of a bruise remains very sensitive for months without apparent induration or enlargement of the part. In such a case it is probable that some nerve has been injured. When the trunk of a nerve has been ruptured, or its fibres crushed, paralysis of the muscles to which it is distributed results, or the site of the injury may become the seat of severe and persistent pain, often neuralgic in character. Contusions occurring in people who have a rheumatic, or, still more, a gouty diathesis, produce much pain and trouble. A blow or fall upon the foot or hand, which would scarcely be noticed in a healthy subject, often provokes severe and prolonged suffering in an individual subject to gout or rheumatism. The same may be said of persons suffering from syphilis or scrofula. Contusions of periosteum or bone in such patients often end in active inflammation and its consequences.

TREATMENT OF CONTUSIONS.

Slight bruises get well of themselves, and require no treatment. When the injury is severe, the first indication is to stop further extravasation of blood. Arrest of bleeding may have occurred spontaneously, before the arrival of the surgeon. If it has not, the best means of preventing further effusion are *elevation* of the part, *rest*, and the application of *cold*. In simple

eases, cold water, or lotions containing spirit of camphor, tincture of arnica, or the hydrochlorate of ammonium, answer a good purpose. Three or four thicknesses of old linen or cotton cloth should be saturated with one of these lotions, and applied to the contused part. The cloth should be kept constantly wet. One of the best applications I have tried in such cases is a mixture of equal parts of whiskey and water. Lotions containing sugar of lead, sulphate of zinc, carbolic acid, acetic acid, vinegar, alum, or common salt, are also used. These applications not only prevent further effusion, but, acting as sorbefacients, encourage the absorbents to take up the blood and serum which has been poured out. Tincture of bryony has long been the favorite local application among pugilists for contusions received in their encounters. It is still used by these people, and is probably more efficacious than the profession generally supposes.

If some one of the larger vessels has been ruptured, and the subcutaneous hemorrhage threatens to be serious, pounded ice, in bladders or rubber bags, should be kept applied to the part. The effect of ice used in this way should be carefully watched, as the vitality of the injured portion is already low, and the depressing effect of cold carried too far may provoke sloughing which otherwise would not occur. In some contusions of the limbs, when the bones have been broken, joints involved, or important vessels injured, but when it is thought that the limb may be saved from amputation, cold, applied by suspending over the injured part a basket filled with ice, is a valuable agent in limiting and controlling inflammation. The contused limb should be laid in a simple fracture-box, the bottom of which is covered with a layer of bran from one to two inches in depth, or, which is better, fine sawdust; this should also be gently packed along the sides of the limb to give support to the broken bones. The limb should be carefully watched, and the basket of ice elevated or lowered, as the condition of the part may demand. This can be effected by attaching to the basket a cord, which should run through a pulley suspended from the ceiling, or any other convenient point. The injured part receives the dripping from the basket, and is kept continually bathed in the cold air which descends from the melting ice. The application of cold by any of the plans suggested prevents further extravasation, and limits the inflammation which, in severe cases, is sure to follow to a greater or less extent.

In aggravated cases of contusion, when the effusion is very great, the circulation feeble, the temperature low, and the vitality of the part endangered, *dry and warm applications* are demanded. The contused part should then be surrounded with flannel or raw cotton, and this covered with oiled silk. Dry is better here than moist heat. After the extravasation has been arrested, and when the danger from inflammation has passed away, *compression* very gently applied by means of a bandage is often useful. It gives a comforting support to the part, relieves pain, and stimulates the absorbents to take up the effused liquids. In slight cases compression may be used with advantage from the first. The formation of a "bump" on a child's head after a fall or blow on the forehead, is frequently prevented by the mother's pressing the spot with a piece of ice or the handle of a spoon. The pressure arrests the subcutaneous hemorrhage, and diffuses the blood already poured out into the surrounding tissues, whence it can more readily be absorbed. Upon the same principle, when absorption is slow, and when there are no symptoms of inflammation present, rubbing and kneading the part hastens the process of cure.

Writers on surgery generally teach that no attempt should be made to draw off the extravasated blood unless symptoms of suppuration are present. If

air be admitted, we are told, decomposition of the blood will take place, and putrefactive suppuration will be set up. To this rule, however, there will be found exceptions. I have, with a common hypodermic syringe, tapped the soft bag of blood which follows contusions of the face, and have thus drawn off by aspiration the greater portion of the effused fluid without the slightest bad consequences. On the contrary, the cures have been more rapid, and the time during which the sufferer has been confined to his room because of a black eye, materially lessened. A common practice among pugilists is to make an opening in the bruised and swollen eyelid and gently press out the blood, and afterwards to apply a cold compress. When it is important to get rid of the ecchymosis quickly, there is no reason why the needle should not be inserted at several points, if entire evacuation cannot be effected by one insertion.

When the extravasated blood is making injurious pressure on important parts, or giving rise to great pain, it should be evacuated in some way. Contusion of the ends of the fingers or toes sometimes produces extravasation of blood under the nails. The pressure upon the delicate and sensitive structures in this locality occasionally gives rise to great pain, which only the evacuation of the blood can relieve. If the toe or finger be immersed in hot water for half an hour or longer, the nail will be so softened that an opening can easily be made through it, and some of the blood permitted to escape. The application of leeches to ecchymoses, so frequently resorted to with the view of drawing out the extravasated blood, should never be attempted. These fastidious little creatures will never drink from the "stagnant pool when they can get at a running stream." They not only do no good as far as getting rid of the "bruised blood" is concerned, but their bites produce irritation, and increase the probability of suppuration. They should be employed only when it is necessary to subdue high inflammatory reaction, which often follows injuries of this character, and then they should be applied at some distance from the bruised spot.

When the contused part becomes hot, red, painful, and throbbing, and suppuration threatens or is actually present, a free, dependent incision should be made, and the blood and serum thoroughly evacuated. The cavity left should be washed out with warm water containing hydrate of chloral or carbolic acid; and, after the bleeding has ceased, a light linseed-meal poultice should be applied. Afterwards, every means should be used to encourage granulation and to promote the closure of the wound. A compress and bandage to keep the walls of the cavity in contact, will hasten the reunion of the parts. If at any time during the course of a contusion, a slough forms, its separation should be encouraged by means of a poultice, and the part, as well as the room, bed, and patient's clothes, deodorized and disinfected by some of the numerous agents employed for this purpose. The best are probably the hydrate of chloral, carbolic acid, the permanganate of potassium, and chlorinated soda. When the contusion is complicated by the rupture of a large artery and the formation of a diffused aneurism, a free incision should be made, and both ends of the vessel searched for and tied. When the soft parts are mashed or "pulped," the bones comminuted, the large blood-vessels or nerves ruptured, or the joints opened—the circulation being feeble and the temperature lowered—amputation to prevent gangrene will be necessary.

CONSTITUTIONAL TREATMENT.—In the earlier stages of a contusion, when absorption of the extravasated blood is being sought for, a low diet should be enjoined, and antiphlogistic treatment generally should be practised. Absorption of the effusion may sometimes be hastened by free purging. When sup-

puration or sloughing has taken place, the patient will need a supporting treatment, and iron, quinine, and nutritious food should be given. At all times, when suffering is great, opium or some other anodyne should be administered, to allay pain and produce sleep. Contusions of internal organs are usually serious and dangerous injuries, the symptoms and treatment of which will be considered in other portions of the work.

STRANGULATION OF PARTS.

When a cord or tourniquet tightly encircles a portion of the body, cutting off all circulation through the bloodvessels, the part below the seat of constriction dies. Surgeons frequently employ this method of strangulation in getting rid of hemorrhoids, vascular tumors, etc. It is not necessary, however, in order to kill the part, that the cord should be tight enough to cut off all circulation; if it simply interferes with it, greatly lessening the arterial supply or preventing venous return, death of the part may equally follow, but it is effected by a slower and more painful process. The cases which come under the observation of the surgeon are generally those of partial constriction, as where a ring has been accidentally slipped over the wrong finger, which it encircles too tightly; or where a bandage has been unskilfully applied to a limb; or, as in hernia, where the bowel escapes through a small opening in the abdominal wall, and strangulation of the intestine is the consequence. The first effect of this partial constriction is accumulation of venous blood in the vessels of the part, and effusion of the watery portions of the blood into the surrounding parenchyma. At first the part looks glossy and cedematous; obstruction to venous return continuing, inflammation sets in; the vessels become still more over-distended; complete stagnation of blood takes place; vitality ceases; and gangrene ensues. The part changes its appearance, becoming mottled, purplish, and finally black in color.

Tying a string around the penis, as has been stupidly done by nurses to prevent children from wetting their beds, or slipping a ring over the penis, has frequently caused mortification of the organ, and sometimes the death of the patient.

TREATMENT OF STRANGULATION.—The treatment is of course to remove the source of constriction as soon as possible. A grooved director can generally be passed under a ring, and by means of a file or cutting-pliers this can be divided and removed. Contracting the penis or finger by the application of ice, will sometimes enable the surgeon to get the ring off; or by wrapping a silk thread tightly around the finger from its point to the ring, slipping the free end of the thread under the ring by means of a needle, and then slowly unwrapping the cord, the ring will be made to follow.

BRUSH-BURN.

Mr. Erichsen has employed this name for a peculiar kind of contused wound, made by severe friction of some portion of the surface of the body. It is frequently caused by the belting or other parts of machinery in rapid motion, coming in contact with the body; or by a rope, which an individual is holding, passing with great velocity through his closed hand. I have seen an extensive "brush-burn" produced on the buttocks and back of a boy, who slipped from his sled while sliding or "coasting" rapidly down a steep hill

covered with ice and snow. Heat is developed by the friction, and the integument is abraded, and in severe cases the subcutaneous tissues are more or less contused.

TREATMENT.—The injured part should be protected from the air, as in the case of an ordinary burn. The separation of sloughs, if formed, should be encouraged by the use of water dressing or poultices, and the resulting sores treated on general principles. Repair will be effected by granulation.

WOUNDS.

BY

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FROM a clinical point of view, wounds may be divided into the "open" and the "subcutaneous," if we exclude those by which animal poisons are introduced into the system, such as dissection wounds, the stings of insects, bites of snakes and rabid animals, and the wounds which afford an entrance to the poisons of glanders, malignant pustule, and, last but not least, syphilis. The term *open* is applied to all injuries caused by external violence—the result either of accident, or, as in operation, of design—in which there is a solution of continuity in the soft tissues, and in which the deeper parts are exposed to the influence of the air, through a more or less gaping orifice. The term *subcutaneous* is applied to such injuries as follow external violence, and in which the deeper tissues, bones, or viscera, are broken, ruptured, lacerated, or crushed, without any breach in the continuity of the soft parts covering them, and consequently without their exposure to the influence of the external air, as well as to such operations as may be done by the surgeon through a small external or open wound—as in tenotomy, myotomy, and osteotomy. *Open* wounds are more serious as a rule than the *subcutaneous*, though when large vessels and viscera are concerned, the latter are among the gravest injuries the surgeon has to deal with. Open wounds, moreover, heal by a more complicated process than the subcutaneous, and are exposed to risks from which the latter are free.

CLASSIFICATION OF OPEN WOUNDS.

When made by a sharp-edged instrument, either by accident or in an operation, wounds are said to be *incised*; when inflicted by a blunt instrument that tears, they are called *lacerated*; and when caused by one that bruises, *contused*. Wounds caused by the thrust of a pointed instrument are called *punctured*, though when the weapon is sharp, the tissues are simply pierced and cut deeply; but when blunt, irregular in shape, or increasing in diameter from the point towards the handle, the soft parts are forced asunder as by a wedge, and are consequently stretched and contused. A punctured wound thus under some circumstances approaches the character of the incised, and under other circumstances that of the contused form of injury. As a matter of fact, however, all wounds of soft parts are more or less contused, those inflicted with a very sharp instrument being, of course, the least so.

A wound is called "simple," when it has been made by a clean, sharp-edged instrument, in a healthy subject, and when there is nothing in the nature of the wound itself, or in the state of the patient, to prevent or retard repair, provided that the injured part be placed in a favorable position for the repair.

tive process to be carried out. The wound is called "complicated," when there are foreign bodies lodged in the part to interfere with repair; when it is attended with hemorrhage, or with much contusion or laceration of tissue; or when from the peculiarity of the patient there are nervous symptoms, severe pain, constitutional disturbance, or local inflammation; or when repair is interfered with by the presence of such complications as bad health or old age.

INCISED WOUNDS.

Open incised wounds are best seen as the result of operations, but they may also be well studied as clean cuts, accidentally made with sharp-edged instruments. They may *gape* from the elasticity or contractility of the tissues divided; may *bleed* from the division or wound of small or large vessels; and may give rise to variable degrees of *pain*, according to the number or character of the nerves involved, and according to the susceptibility of the patient.

GAPING OF INCISED WOUNDS.—The amount of *gaping* in a wound varies with the tissue divided. *Skin*, which is the most elastic tissue in the body, retracts when divided far more than other tissues, and transverse wounds of skin gape more than those which are longitudinal. *Arteries*, when wounded transversely or obliquely, gape much, and when completely divided across, retract far into the tissues. Divided *veins* retract less than arteries. *Muscles*, when their fibres are cut across, shorten rapidly by contraction, and thus aid the gaping of a wound. *Fibrous tissues* and *nerves*, when divided, retract but little. All wounds, however, which are made in parts in a state of tension, gape much, and tissues which are on the stretch when divided, retract far more than they would do if they were relaxed. Thus an incision made into the full breast of a suckling woman, will probably by gaping appear as wide as it is long; while one made into the same organ in a flaccid state, would gape but little. Some tissues, on the other hand, never gape on division; this is best seen in wounds of the palm of the hand, and of the sole of the foot.

The surgeon takes advantage of these known conditions of gaping and retraction of tissues, and in his operations so places on the stretch the parts to be divided, as to enable him to make a clean and decisive section of the tissues with which he is dealing—a single sweep of the knife, made under these circumstances, doing the work of many when made under others less favorable.

HEMORRHAGE FROM INCISED WOUNDS.—The *bleeding* that attends an incised wound depends principally upon the size, number, and character of the vessels that are divided, although it may be influenced by the personal peculiarities of the patient, and more particularly by the fact of his being a "bleeder," or not; or, in other words, by his being, or not being, a subject of the "hemorrhagic diathesis." The condition of the wounded part, moreover, whether inflamed, or otherwise more than normally supplied with blood, has some influence; and the effects of position must always be taken into account. Putting aside, however, these peculiarities, constitutional and local, the myriads of vessels that are divided in a wound made in a healthy subject with sound tissues, rapidly if not instantaneously close on the removal of the dividing medium; for it is a fact that capillary bleeding after an incised wound rapidly ceases by natural processes, and that what goes by the name of "hemorrhage" is due to the issue of blood from wounded arteries of some size, or from wounded veins, the bleeding, if it does not prove rapidly fatal, persisting till nature's hæmostatic processes—unassisted or assisted by art—have had time to act.

PAIN OF INCISED WOUNDS.—The *pain* attending an incised wound varies in its nature and degree, according to the position of the wound and the tissue wounded. Some portions of the body, such as the skin of the face and fingers, orifices of the mucous tracts, periosteum, or tense tendons, are far more sensitive than the skin of the back or buttocks, the bones, and the fasciæ. The sensibility of the patient has likewise much to do with the degree of pain experienced, as has the condition of the nervous system at the time at which the wound is received. Not only may one subject of an operation be far more sensitive than another, but the same person may feel pain more acutely at one than at another time, the general condition of the physical powers, and more particularly of the nervous system, greatly influencing sensibility.

Unexpected or unseen wounds, or wounds received during drunkenness, or when the mind is intent on other things, as in the excitement of battle, are often unfelt, or felt but slightly; whereas when the mind of a patient is fixed upon the performance of an operation, the evil influence of anticipation aggravates his suffering.

LOCAL AND CONSTITUTIONAL EFFECTS OF INCISED WOUNDS.

The *local effects* of a simple incised wound, in a healthy subject, may extend little beyond the breach of surface, and the slight pain and bleeding which attend the injury. The *constitutional effects* may be so slight as to be unobserved. In a general way, however, local as well as constitutional effects show themselves, and these are greatly influenced by the extent of the wound, the general condition of the patient, and the treatment to which the injured part and the patient have been subjected.

LOCAL EFFECTS.—The *local effects of a wound* are best studied in a deep, incised cut, which has passed through skin, subcutaneous fat, and fascia. The wound, directly after its infliction, will gape, and, after the lapse of but a brief interval of time, this gaping will increase, so that the subcutaneous fat will appear as if it were being pressed out of its position, and as if the divided edge of true skin were retracting from it, and becoming everted. Within an hour or an hour and a half, the edges of the wound will be seen to be *swollen* and slightly *red*, from increased vascularity, and, where the connective tissue of the wounded part is loose—as in the eyelid or the male genital organs—puffed up and *œdematous*. To the patient, the part will feel hot and stiff, and it will be the seat of a dull, aching, or burning pain. The edges of the wound will also probably be more sensitive, the amount of pain depending much upon the *tension* of the parts, and upon the treatment to which they have been subjected. If the edges of the wound have been stitched together, and the parts are much swollen and *œdematous*, there will be tension upon the wound, and a disposition to separate and gape. In a healthy subject, however, when repair goes on well, all these local phenomena will subside and disappear in the course of two, three, or four days, according to the rapidity and perfection of the healing process, and a cure will then take place. But should the local phenomena above described be more persistent, increase in severity, spread beyond the margins of the wound into surrounding parts, or alter in character for the worse, what has been a physiological, reparative process will pass into a pathological or diseased one, and the parts will then be said to be “inflamed.”¹

¹ See vol. i. p. 65.

CONSTITUTIONAL EFFECTS.—The *constitutional phenomena* associated with these local changes, vary greatly. In some subjects, a trivial, local injury, a mere cut, may give rise to severe shock, or to a disturbance of the nervous system which expresses itself in convulsions; whereas in another, a severe and extensive wound may be followed by few if any constitutional symptoms.

Shock.—The gradations of *shock* and *collapse* are innumerable, and the symptoms by which they are characterized vary from a passing faintness or disturbance of the heart's action, to fatal syncope. The state of collapse may be regarded as a chronic syncope. Patients may unquestionably die from shock following slight injuries or minor operations, though no satisfactory cause for death may subsequently be discovered, the heart's action in these cases being suddenly stopped through some central nervous influence. The degree of shock that attends an accident or operation depends as a rule, however, upon the importance of the injured organ in the animal economy, the extent and nature of the violence which the tissues have sustained, the size of the bloodvessels which have been involved, and the amount of blood which has been lost.

A patient, in good general health, will bear a severe wound or operation with little shock, while another with diseased viscera, and more particularly with diseased kidneys, will be subjected to severe shock from even a trivial injury. The age and constitutional condition of the patient have an important influence under all circumstances.

Reaction.—When what has been described as the period of "shock" after an accidental or operative wound, has passed away, the stage of "reaction" is reached, and in a general sense it may be assumed that the intensity of this stage is fairly governed by the intensity of that which preceded it. That is to say, where there has been little shock, there will be but feeble reaction; and where the shock has been severe or prolonged, the stage of reaction will be of a like type. Still this rule has innumerable exceptions, and these exceptions seem to depend more on the individual peculiarities of the patient than upon anything else: one person, after a slight injury or operation, experiences little shock, but sharp reaction; while another, suffering from a severe injury or operation, will have a prolonged stage of shock, followed by no more reaction than seems to be necessary to restore the circulation to its normal condition, and to allow the functions of the body to work efficiently. Children and women, and the subjects of neurotic tendencies, always react rapidly and in a marked way from all kinds of shock, whether mental or physical, but at the same time these subjects, as a rule, do well. The rigors, nervous tremblings, and fears, which are often met with in nervous subjects after operations, and which often cause alarm, are but rarely followed by any bad results.

The *symptoms of reaction*, in their mildest expression, are simply those of the restoration of the nervous and circulatory functions to their normal condition—the heart, with the circulation generally, so rallying from the depressed condition into which it has been thrown by the "shock" of the accident or operation, as to come up to the usual standard of health; and the nervous system so recovering from the temporary state of depression, if not of unconsciousness, into which it has been cast, as to resume its normal power of governing and controlling the actions of the body over which it presides. The reparative process consequently, under these circumstances, may be expected to go on uninterruptedly to a successful issue; the wound will undergo repair, and heal, and the subject of the wound will suffer little or no constitutional evil beyond that occasioned directly by the injury. The

stage of reaction, in a clinical sense, will then be normal; it will be such as may be said fairly to balance that of shock, and to tend towards recovery.

Traumatic Fever.—When the symptoms of reaction, either with respect to intensity or duration, exceed this normal standard; when the circulatory system acts powerfully and rapidly, the respirations increase in quickness, the brain and special senses become abnormally active, and the temperature of the body rises, and remains above that of health; and when, with this elevation of temperature, the functions of the body generally are disturbed and work badly, as indicated by thirst, a foul tongue, loss of appetite, constipation, diminished secretion of urine, want of sleep, or disturbed rest—*traumatic fever* is said to exist.

This fever may show itself the day after the injury or operation, or may not appear till the second day, and it may last for twenty-four, forty-eight, or even seventy-two hours. When the case is going on satisfactorily towards recovery, the fever seldom lasts beyond this period. Should the symptoms, however, continue, dangers are to be apprehended, and difficulties looked for. When the fever runs on into the fifth or sixth day, the surgeon may be sure that some complication is present, and, should the symptoms be still more fixed, the probabilities are that the case is not only badly complicated, but that it will pass on to a fatal issue.¹ Under all circumstances, and in the treatment of every wound, accidental or operative, the eye of the surgeon should be steadily fixed on the temperature chart—such a chart affording the surest indication of the advance or presence of any evil complication.

PROCESS OF REPAIR IN WOUNDS.

Before entering into details, it is well to know, as a primary truth, that the processes of repair are identical in all tissues; that the reparative process in bone or muscle, integument or tendon, soft or hard parts, is the same, such modifications alone showing themselves as necessarily appertain to the anatomy of the tissue or special circumstance of its position. Thus, tissues that are highly vascular, may undergo more rapid and more perfect repair than others less fortunately circumstanced, and bone tissue may require more time to unite than skin, yet in all the process is alike. Let us therefore inquire what the process is, and see what changes take place in parts undergoing repair; and then look at them where they are best seen, where an incision is made through the skin and the edges are brought together.

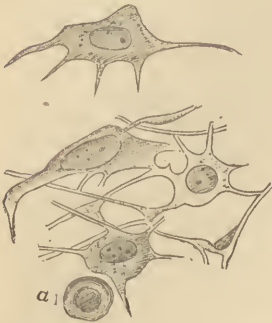
IMMEDIATE UNION.—The chief points that can be observed have reference to the capillaries. In these, at the margin of the wound, the blood will be found coagulated up to the nearest anastomosis, and the capillary vessels in the neighborhood will be seen to be dilated—this dilatation being caused by the increase of pressure to which the capillaries have been subjected by the altered circulation of the blood in the immediate vicinity of the wound. When wounds unite by *immediate union* (the “first intention” of Hunter), no other changes than these take place, beyond the gradual restoration of the capillary circulation through the parts that have been divided, and under these somewhat rare circumstances no scar or cicatrix is left. The soft parts at first simply adhere together, and consequently become continuous.

PRIMARY ADHESION.—Should the wound unite by what is called *adhesive union* or *primary adhesion*, in which a cicatrix is formed, other changes are to be

¹ See a paper by the author, in the *Lancet* for June 5, 1880.

seen; and these take place in the connective tissue—in which the vessels of the part ramify—a tissue that pervades every other, and which is made up of cell elements and inter-cellular tissue, the cell elements varying according

Fig. 215.



A group of placoids in different stages of growth; *a*, embryo cell wandering. (After Golding-Bird.)

to the nature of the part in which it is found. These changes consist of cell multiplication, and, under the circumstances supposed, we find between the edges of the wound a vast accumulation of cells, filling up in various degrees the spaces of this wounded tissue. It is through these cells that cicatrization takes place, these cells being in part simple nucleated cells, which may be called "embryo cells," with connective-tissue corpuscles containing a nucleus and nucleoli—Klein's "Placoid Cells."¹ (Fig. 215.)

Whether this cell multiplication depends upon changes in the cell itself, as Virchow affirms, or whether the cells are the white corpuscles of the blood which have escaped by exudation from the capillaries, as Cohnheim would lead us to believe, I do not now care to inquire. All admit, however, the multiplication of cells in the affected tissues.

Professor Redfern writes:² "the facts must be recognized; the floating blood-cells are really the very cells which once formed the substance of the lymphatic glands, the spleen, and other organs; and they do, in fact, move through the walls of the blood passages, and wander about freely in what are called solid tissues." When we recollect how penetrable the tissues of an animal are, we shall cease to be startled at seeing those parts become the seat of entirely new deposits, or finding them traversed by migrating blood-corpuscles as freely as a colloid is penetrated by a crystalloid.

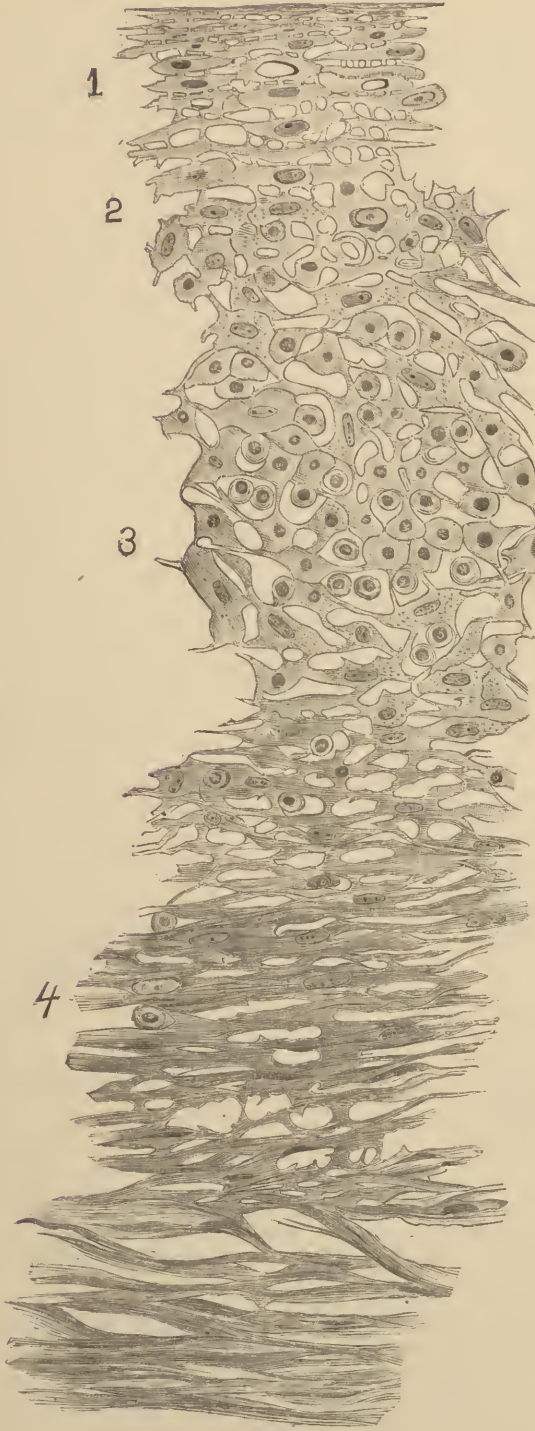
CICATRIZATION.—Let us now inquire briefly how cicatrization proceeds, and note that it is in the cells that the most important changes are to be recognized. Those nearest the injured part gradually assume a spindle shape, and the intercellular tissue into which these spindle-shaped cells are infiltrated becomes denser. The spindle-shaped cells then gradually change into ordinary connective-tissue corpuscles, and in this way new cicatricial tissue is formed. (Fig. 216.) This new tissue, however, again undergoes changes—changes of consolidation. The intercellular tissue becomes gradually more condensed—the spindle-shaped cells also assuming the flat shape of connective-tissue corpuscles, and in a measure disappearing, the nucleus often alone remaining—the fluid that existed in the newly formed tissue is absorbed, and the new cicatrix by degrees thus becomes firmer and denser, gradually contracting, so that at last the delicate scar of a large wound becomes solid and compact—the cicatrix in smaller wounds appearing only as a thin, red, and at a later period as a white line.

Changes in the capillaries of the part are, however, going on during all this period, and how far *all* the changes that have been briefly described are due directly to the capillary action, is not yet determined. If Cohnheim's views be adopted, it is to the capillaries that the chief action in the tissues must be ascribed, but if those of other pathologists, such as Virchow and Billroth, be accepted, the capillary action takes a secondary place, and the cell elements

¹ Figs. 215–219 are taken from a valuable paper written by my friend, Mr. Golding-Bird, and published in *Guy's Hospital Reports*, 3d s., vol. xxiv (1879).

² Address at meeting of British Association, 1874.

Fig. 216.



Semi-diagrammatic view of a section through a healing ulcer. 1, Epithelium formed; 2, Placoid cells developing into epithelium; 3, Region of granulation tissue; most of the cells are embryonic and free in the meshes of protoplasm; placoids exist in numbers to form—above, epithelium—and below, fibrous tissue; the cells with a round granular nucleus are transitional; 4, Tissue undergoing clearing; it contains but few embryo cells; the protoplasm is arranging itself in transversely elongated meshes above, but below it becomes fibrillated; the placoid nuclei, which appear as dark rods, become the connective-tissue corpuscles of the new fibrous tissue. (After Golding-Bird.)

take the leading one. On either theory, the importance of the capillaries cannot be overlooked.

With regard to the changes in the capillaries, it has been already pointed out that, at the beginning of the reparative process, those of the part become sealed, and the collateral circulation in the neighborhood becomes irregular and pressed upon; and that the coagula in these obliterated capillaries become reabsorbed or possibly reorganized as repair progresses, since it is certain that the capillary network soon becomes continuous through the newly formed cicatricial tissue, and that the capillary meshes of the one side join, by loops projected through the new tissue, similar meshes of the opposite side.

What influence the *nerves* of the part have upon the reparative process, we do not know. That they have an important influence there can be little doubt, since all physiologists recognize their power upon secretion and nutrition; the vaso-motor nerves doubtless have the greater power. But we must learn something more of nerve power generally, and of nerve distribution—something of the way in which the nerves terminate in the tissues, and what relation they bear to the capillaries—before we can hope to find out or understand the exact influence which nerve supply has on repair.

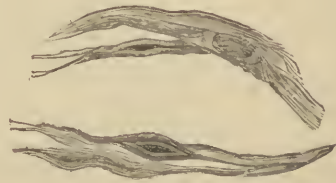
REPAIR BY GRANULATION.—All wounds do not, however, heal by immediate union, or by primary adhesion, and wounds that gape cannot so unite. The process of repair in these, therefore, differs somewhat in its character from the process in those which we have been considering; it takes place by *granulation*, or the “second intention” of Hunter. If we closely examine the surface of a wound thus exposed, we shall find that it becomes, within a few hours of its exposure, covered with a film of a peculiar, gelatinous, grayish-white appearance. This will be seen with the aid of the microscope to be composed of granulation-cells or white blood-cells, Hunter’s “plastic lymph.” After an

Fig. 217.



Bloodvessel forming in *a*, granulation tissue; the wall, *b*, forming from placoids and protoplasm. (After Golding-Bird.)

Fig. 218.



Spindle cells, developed from placoids, from the walls of a forming bloodvessel. (After Golding-Bird.)

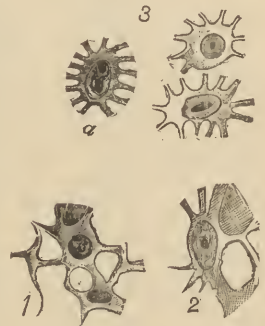
interval of some hours, the parts covered with this gelatinous grayish film become more vascular, as indicated by redness, and the surface more even. The film itself assumes a tougher character, and a yellow fluid, which is mixed with small yellow sloughs of fibrinous tissue, is secreted. The wound begins “to clean,” and to have a smooth and consistent surface. After the lapse of another day, or some days, perhaps, this surface is covered with a number of elevations, known by the name of *granulations*, varying in size from a millet-

seed to a hemp-seed, the smaller being highly vascular and red, the larger being, as a rule, paler and more bloodless. The wound at this time is "granulating." The secretion from these granulations is now of a creamy-yellow character, and is called *pus*. They are made up of cells called granulation cells, which resemble inflammatory lymph-cells, each granulation being composed of a capillary loop surrounded by simple, nucleated, embryo cells, and by connective-tissue or placoid corpuscles (Figs. 217 and 218). Of the nuclei, Paget says:—

"Some of these nuclei are arranged longitudinally, others transversely, to the axis of the vessels." In the development of these vessels changes occur, answering to those seen in ordinary embryonic development. "Organization makes some progress before ever blood comes to the very substance of the growing part; for the form of cells may be assumed before the granulations become vascular. But for their continuous active growth and development, fresh material from blood, and that brought close to them, is essential. For this, the bloodvessels are formed; and their size and number appear always proportionate to the volume and rapidity of life of the granulations. No instance would show the relation of blood to an actively growing or developing part better than it is shown in one of the vascular loops of a granulation embedded . . . among the crowd of living cells, and maintaining their continual mutations. Nor is it in any case plainer than in that of granulations, that the supply of blood in a part is proportionate to the activity of its changes, and not to its mere structural development. The vascular loops lie embedded among the simplest primary cells, or, when granulations degenerate, among structures of yet lower organization; and as the structures are developed, and connective tissue formed, so the bloodvessels become less numerous, till the whole of the new material assumes the paleness and low vascularity of a common scar."¹

If at this time, when the granulations have attained to the level of the skin, we look to the margins of the wound, we shall see a dry, red band of newly formed tissue, with an outer border of a bluish-white color, where it comes into contact with sound integument. This band is the new skin forming, and is caused by the gradual growth of the epidermis from the margin of the sound skin towards the centre of the sore. Such a process is called *cicatrization*. The cicatrix is at first red, as in the linear cicatrix to which we have already alluded, but, as it then contracts, it subsequently becomes paler, and more compact and adherent. The nature of the scar or cicatrix varies with the tissue in which it is formed, the new connecting medium or cicatrix under all circumstances having a powerful tendency to adapt itself to the peculiar character of the tissue in which it is placed. Thus, a cicatrix in skin, in time closely resembles true skin; a cicatrix in bone, true bone; and a cicatrix in tendon becomes tough and hard, like tendon; the consolidating, reparative material in every instance partakes of the character of the parts which it connects. It is corpuscular in its origin, and clearly fibrinous in its nature; but whatever the origin may be (though there is considerable divergence of opinion about it), its existence is undoubted, and through it and by it all repair takes place.

Fig. 219.



Epithelium developing from granulation cells in the order of the figures 1, 2, 3; No. 3 shows the fully-formed "egg-wheel" cell, at *a*, becoming vacuolated by the loss of its nucleus. (After Golding-Bird.)

SECONDARY ADHESION.—When two granulating surfaces are brought together, and union takes place between them, healing by *secondary adhesion*,

¹ Paget, Lectures on Surgical Pathology, Third edition, page 165. London, 1870.

or by the *third intention*, is said to occur. The process of repair under these circumstances is similar to that of adhesive union, the two layers of granulations adhering in the one case, as the two surfaces of divided tissue do in the other, by means of new material. The capillaries and embryo-cells under both circumstances undergo changes such as have been described. For this form of union to take place, the granulations, however, must be healthy.

REPAIR BY SCABBING.—When wounds heal by *scabbing*, granulations do not form. In this process, the reparative material which is poured out, undergoes at once similar changes to those already described as taking place in adhesive union, and the wound cicatrizes rapidly beneath the scab; for the serum of the blood, when effused on the surface of a wound, is of a highly plastic character, and quickly coagulates to form a film of a protective nature, under which repair may rapidly proceed, the embryo cells, with this plasma—Hunter's "plastic lymph"—being the medium of repair. Advantage is taken of this fact in the treatment of superficial wounds, the value of felt, cotton-wool, or any similar material, when applied to an open wound, entirely depending upon this plastic property of blood. Repair by scabbing is doubtless the best form of healing, although it is, unfortunately, somewhat rarely obtained.

NATURE OF HEALING PROCESS.

The nature of the healing process is physiological, and resembles closely that of development and growth; the changes in the cell elements which have been described in repair, and the gradual development of the most elementary tissue into cicatricial tissue or higher structures of the human body, are similar in nature, if not in form, to those which are witnessed in the embryo, when the blastoderm cells in the ovum, or primary nucleated mass of protoplasm, grow, develop, and differentiate into the various structures of the human animal. In both of these processes, there must be pabulum for nourishment, such as the blood, and there must be a sufficient supply of it; there must likewise be a regulating force to control and direct the formative process, and this force doubtless comes from the nerves. When the vascular supply is deficient, repair, growth, or development must suffer, and the physiological process of repair cannot go on; when the vascular supply is in excess, what would have been a physiological, becomes a pathological process, and the part undergoing repair after injury is said to be "inflamed." The process of *construction* under these circumstances ceases, and that of *destruction* may ensue; or there may be other changes in the inflamed and formerly repairing wound or granulating surface, which will be considered on a subsequent page, under the heading of Diseases of Granulations. What I would now impress upon the reader, is, that whatever action is required for the healing process is physiological, and is just equal to its purpose; when it is excessive, it becomes pathological, and is known as inflammation—inflammation, when it attacks a wound, at first checking repair, subsequently undoing it, and, at a still later period, bringing about disorganizing changes; inflammation, under all circumstances, having a destructive tendency.

REGENERATION OF TISSUES.

It has already been asserted that the processes of repair are identical in all tissues; that the reparative process in bone or muscle, integument or tendon,

capillary or nerve, is the same, such modifications alone showing themselves as necessarily appertain to the anatomy of the tissues. It is well that this physiological truth should be fully recognized, but, at the same time, it is to be equally recognized that all tissues are not formed out of cicatricial or connective tissue, and that the higher forms of structure, such as muscle, nerve, bone, etc., are repaired by the regenerating influence of the injured tissue itself, new cells springing or growing by a kind of budding process from the divided ends of the injured part, and the new cells in contact with, or poured out by, the injured tissue, whether as embryo cells, connective-tissue cells, nerve cells, muscle cells, or bone cells, being so influenced by the tissue with which they are in contact, and from which they probably have originated, that they anatomically partake of its nature, and more or less thoroughly bring about its repair.

REPAIR IN MUSCLE.—Thus, when *muscular tissue* is wounded, or more or less destroyed, O. Weber tells us that it may be restored, and that the young muscular fibres are formed out of the old by the division of the protoplasmic material of their extremities, the repair of muscle being thus brought about by agencies closely simulating those of fetal development, in which the young muscular elements are formed almost entirely out of the cells contained within the old muscular fibres. Gussenbauer even gives a drawing of the process (Fig. 220), but Billroth declares that he has never seen anything which

Fig. 220.



Process of regeneration in striped muscular fibre after injury. Magnified about 500 times. (After Gussenbauer and Billroth.)

he could regard as a re-formation of muscular fibres, and that the cicatrix in muscle is almost entirely connective tissue; the extremities of the muscular fibres, after division and repair, uniting with the cicatricial tissue in the same way as they do with the tendons. My own observations go to confirm those of Billroth.

REPAIR OF NERVES.—It may with confidence be asserted that an injured or even a divided nerve may be thoroughly repaired, since conclusive evidence has in recent times been adduced to prove that such a large nerve-trunk as the median, the ulnar, or the great sciatic, may be divided and subsequently so joined by surgical skill as to secure, after the lapse of a certain interval of time, perfect union of the divided ends, as proved by the complete restoration

Fig. 221.



Fig. 222.



Regeneration of nerves.

From a rabbit, fifteen days after section; young spindle cells in the nerve-ends, developed from the connective-tissue, and ultimately connected with the neurilemma. (After Billroth.)

From a frog, ten weeks after section; development of young nerve cells from spindle cells. Magnified 300 times. (After Hjeltn and Billroth.)

of the functions of the nerve in their physiological perfection.¹ It is likewise true that new cicatricial tissues become sensitive, and that parts which, by accident or operation, have been deprived of the influence of one nerve regain their sensibility, either by the growth of new nerves, or by the assumption on the part of another branch of the same nerve, or of another nerve, of the physiological functions of the one that has been destroyed. Hence the conclusion is clear that nerve-tissue must be regenerated, and that the divided ends of nerve must re-unite by new nerve material. It seems, moreover, highly probable that new nerves may be developed. In a physiological point of view, these facts are not only very remarkable, but they tend to demonstrate the perfection of the reparative process, since to allow of the conduction of nerve-force to and from the nerve-centres, very perfect conductors are unquestionably required. The process by which this repair is brought about has been carefully studied by Schiff, Hjeltn, and others, and is much after the following fashion, as given by Billroth (Figs. 221, 222):—

“There is, first of all, a degeneration of the medullary sheath, possibly also of the axis cylinder, for a certain distance from the injury, which is quickly followed by the production of cells in the neurilemma; these develop into spindle cells and spread into the tissue which intervenes between the nerve-fibrils, and which extends also between the cut extremities of the nerves. From these cells, as in the embryo, new nerve-fibres are developed,” and these new fibres “ultimately cannot be distinguished from ordinary nerve-fibres.”²

¹ Weir Mitchell, *American Journal of the Medical Sciences*, April, 1876; Hulke, *Transactions of the Clinical Society of London*, vol. xii.

² Billroth, *Lectures on Surgical Pathology and Therapeutics*, vol. i. p. 152. London, New Sydenham Society, 1877.

SOURCES OF INTERFERENCE WITH HEALING OF WOUNDS.

The different modes of healing, and the processes by which injured tissues are repaired, having been fully described, I propose to consider next the causes that interfere with, retard, or prevent repair; and these may be found either in the *subject of the wound*, in the *wound itself*, or in its *treatment*.

PRESENCE OF FOREIGN BODIES.—Amongst the causes which pertain to the wound itself, the presence of any *foreign matter* whatever must be placed first, since it is clear that where such is found, even to a very limited extent, repair by immediate, primary, or quick union is impossible; the foreign matter not only, by its presence, mechanically prevents the adhesion of the surfaces between which it is placed, but also acts as an irritant, or as a promoter of septic changes, and thus excites an action in the wound which is not reparative, but inflammatory. The truth of this general rule is not disproved by the fact that, in exceptional cases, foreign bodies become encysted in tissues, and give rise to but little trouble.

HEMORRHAGE.—The occurrence or persistence of *bleeding* in the wound is a second local cause of non-repair, the reparative process not commencing until all bleeding, even capillary oozing, has been arrested. When the hemorrhage is great, this interference may be serious, and even when little, it is enough to retard and prevent the reparative process from being carried out. Blood, if effused to any extent between the sides of a wound, interferes with the reparative process much in the same way as does a foreign body, and forbids all healing by quick or primary adhesion. If effused in very small quantities between the divided surfaces, it may at times possibly change into cicatricial tissue, and form a bond of union between the divided parts; and under other conditions it may become organized, as when poured out on the brain; but, as a rule, the effusion of much blood into a wounded part is a retarder of repair, or a cause of non-repair. When a wound has to heal by granulation, a clot of blood, as a covering, kept aseptic, is beneficial, since it acts as a protector to the surface of the wound, and allows the granulating process to go on uninterruptedly. It has been said that such clots become organized, but it is far more probable that they simply act, as above described, as a protection to surfaces that are granulating.

CONTUSION AND LACERATION.—A *contused or lacerated surface* in a wound is a third local cause of non-repair, and it is well to recognize this important fact, since, with such a condition of parts, the surgeon knows that immediate or primary union of the wound is not to be expected. Under these circumstances, a line of treatment will be indicated, which will be far more likely to be efficient than one based on the hope of obtaining quick repair. When the contusion or laceration is slight, the hope of securing primary union of the divided parts may indeed be entertained, but, under opposite conditions, such a hope would be altogether groundless. The gradations of contusion and laceration between these two extremes are numberless; but it will be wiser for the surgeon to believe—and upon such a belief to act—that in contused and lacerated wounds the prospect of obtaining quick union is slight, than for him to act upon an opposite view, and attempt to obtain, in severe cases, a mode of healing the occurrence of which is improbable, if not impossible.

In a contused or lacerated wound, the surgeon should mentally see dying or dead matter, which, of necessity, must be separated from the living parts

and got rid of, either by molecular disintegration or by a coarser, sloughing process, before the act of healing can rightly be said to begin; and under these circumstances he will at once recognize the futility of entertaining a hope of obtaining the repair of the wound by quick union.

CONSTITUTIONAL CONDITION OF PATIENT.—Of the causes of non-repair which are to be put down to the account of the subject of the wound, *age* is all important, the reparative process in a man on the wrong side of fifty being conducted with less vigor than in one who is on the right side. In the very old, repair is at its lowest mark. The same remarks are applicable to patients who are the subjects of *organic disease*, or of *degenerative changes* in their tissues, and especially to fat and soft-tissued people; the old in years, or in infirmities, not possessing the recuperative powers of the young and vigorous. Under these circumstances, in the case of a wound resulting from accident or operation, in a patient over fifty years of age, or in one in ill health, it would be wrong for a surgeon to expect, or to rely upon securing, a mode of repair which, in a younger or healthier subject, he might reasonably look for; people who are advanced in years, or who are feeble from frailty or disease, particularly visceral disease, have no or an insufficient capital at the bank of health to draw upon. Of all subjects for wounds, whether accidental or operative, the habitual drunkard is the worst.

DEFECTS IN TREATMENT.—Of the causes of non-repair which are to be attributed to treatment, a want of due care in maintaining the injured or wounded part in a state of *rest*, claims the first place, for in such a delicate process as is that of repair, it is plain that in any movement of the injured part, whether in the way of separation of surfaces or manipulation, the process may be interfered with or retarded, or the work already accomplished undone. Indeed, since it is certain that the best and most rapid repair of an injured part takes place when the wounded tissue is kept in an absolutely immovable position, and when the wounded surface is protected from all external influences that can possibly interfere with the physiological, reparative process, it clearly behoves the surgeon to have this great truth always before him, in order that he may adapt his treatment to the requirements of the case before him, and not have to blame himself—on account of some failure in the healing act—for a want of care in maintaining that absolute immobility of the wounded or cut part which is essential for rapid or even good repair. In the treatment of fractures, the evil effects of want of rest and immobility of the broken bones are well exemplified, but it is to be remembered that the same want of rest and immobility is as pernicious in wounds of the soft as in those of the hard parts; in wounds of the surface as in those of the deeper structures. The term “want of rest” is here used in its fullest sense, as want of that thorough immobility of tissue, which is all important for the rapid perfection of the physiological, reparative process.

Again, if the edges of a wound are allowed either to gape, or to have too much tension upon them, repair will be interfered with—the parts, in both cases, from want of care in their adaptation, want of caution in not making due provision for the escape of the redundant fluids (drainage), or from some overaction (inflammation), not being allowed to remain at rest and undergo repair.

Overaction in the vessels of a part which is undergoing repair—that is, inflammation—always has an evil influence. When it shows itself early in the case it prevents repair, and when manifested at a later period it retards the healing process, or even causes retrogression. Indeed, under all circumstances, when the vascular action of a part which is undergoing repair ex-

ceeds what is essential for the steady perfection of the process, the repair of that part is interfered with. Inflammation (to repeat what has been already said) when it attacks a wound, at first checks repair, subsequently undoes it, and, at a still later period, brings about disorganizing changes. Inflammation has, under all circumstances, a destructive tendency.

The student, having learnt how wounded parts heal by nature's processes, and more particularly how simple incised and open wounds are repaired; and having moreover learnt to recognize some of the most important influences which retard, if they do not arrest, repair, will readily understand the more favorable conditions under which repair can be carried out, and, what is more, will at once appreciate the surgical requirements of the case he may have to treat, so that, as a surgeon, he may know when and where to apply his art, how he can help nature in her beneficent action, and how he can best guard against the intrusion of any outside influences that may tell against the steady progress of the reparative process. For it cannot be too strongly asserted, that the best surgeon is the one who best understands natural processes in the repair of parts, and who knows how to use them to the greatest advantage; who recognizes the fact that these natural processes are exact and, when applied to the healing of wounds, undeviating; who knows that if he is to utilize these natural processes to the full, he must bring up his art of curing to nature's line, under the conviction that nature never systematically bends herself, or puts forth her hand, to help the curer; that she never deviates from her path; that if, using Dr. B. W. Richardson's words, "we do not molest her, she goes on, as we say, naturally, towards a cure; if we molest her a very little, she goes on, and the molestation is but little shown; if we molest her vehemently, she still goes on, showing molestation in proportion to disturbance, nature under all circumstances going her own way, caring just as little for ease as for pain, for life as for death."

When a bone is broken, nature will heal it quite irrespectively of the position in which it is placed; when a knuckle of bowel is strangulated, nature will cast it off quite regardless of the effects of such a sloughing act. But the surgeon who knows this, knows moreover that the same natural process will work on where the bone is "set" in a right position, and maintained there by art; and that the sloughing may be avoided when the strangulated bowel is relieved by art from its false position, and placed where it can be best repaired by nature's means.

TREATMENT OF WOUNDS.

In the treatment of a simple cut, or incised wound, in which there is no dirt or foreign matter to keep the edges of the wound apart, and to act as an irritant or exciter of overaction, and no hemorrhage beyond capillary or venous bleeding which can be arrested by elevation of the part, moderate pressure, or the application of a cold or hot sponge, the surgeon has simply to cleanse the wound, bringing its edges carefully together, and adopt means to keep them so, while at the same time he makes such provision for the protection of the part as may secure it from injury from without or within, and may allow the reparative process which has been described as taking place in primary union to be quietly perfected. In more severe wounds, a similar practice is to be advocated, though more care may be called for in cleansing the wound; more caution required in the arrest of bleeding; and more ingenuity demanded in bringing the edges of the wound together, as well as in so fixing the injured part in position that the patient may be comfortable, while the wound is kept immobile and protected from such injuri-

ous outside influences as would interfere with the healing act. Provision moreover will have to be made for efficient drainage, that is, for the free exit of such sanguineous or serous fluids as are commonly exuded after severe wounds or operations, and the retention of which always proves injurious. Upon each and all of these points a few lines may not be without value.

CLEANSING WOUNDS.—After full examination of a wounded part, and clear knowledge as to the mode of its production, the extent of injury, and the requirements of the case for cure, the wound should be cleansed. This should be effected with all completeness and gentleness, since, on the one hand, everything like a foreign body between the lips of a wound would of necessity prevent quick or primary union, and would in all probability prove injurious to the subsequent progress of the case, while, on the other hand, anything like roughness would be detrimental to the already injured part. To effect this cleansing with gentleness, a stream of water, medicated with some antiseptic, is the best means for the surgeon to employ, and this stream may be brought to bear upon the part by using the irrigating bottle (Fig. 223), or the

Fig. 223.



Irrigating bottle.

irrigating apparatus (Fig. 224). The stream of fluid washes away blood, with all light foreign matter, and what cannot be thus washed away may be removed with fingers or forceps. In gunshot wounds, special forceps and other instruments may be required.

Fig. 224.



Ward carriage with irrigating apparatus for cleansing wounds.

Those who believe atmospheric germs to be the chief cause of inflammation and suppuration, or of most, if not all, the ills to which wounded flesh is heir, will employ the means that are supposed to be capable of destroying such malignant foreign visitors, and for this purpose will use the spray of carbolic acid, one part in forty, or other antiseptic, to kill the germs in the air as they approach the wound, and will dress the wound with the carbolic lotion, carbolic gauze, protective, and waterproofing, according to the directions laid down in the Article on the "Antiseptic Method of Treating Wounds," whereas those who disregard at-

mospheric germs, and yet highly value means for purifying wound surfaces, will use antiseptic irrigation of the wound with a lotion of carbolic acid, 1 to 20; of thymol, 1 to 1000; of chloride of zinc, 20 grains to the ounce (originally used by Mr. C. de Morgan, many years ago); or of iodine, made by adding 20 drops of the tincture to the ounce of water. I have employed the iodine lotion for years, and prefer it to any other. It is always at hand, and is both simple and effectual as a wound cleanser. The lotion may be used warm, and it has the advantage of not only cleansing the wound in the fullest sense of the term—for iodine is an antiseptic—but it has a marked tendency to arrest all capillary bleeding or oozing. I use it in about the proportions given above, but the best practical guide is to pour the tincture into a basin full of water, so as to make the latter of a light sherry color.

ARREST OF BLEEDING.—It is well that all hemorrhage should be effectually arrested by some of the various means which the surgeon has at his command, before the edges of a wound are brought together; and it is wise to have even capillary oozing stopped, when it is possible, for blood effused in even limited quantities between the surfaces of an incised wound is to be regarded much in the light of a foreign body, and as forming an obstacle to repair, more particularly when primary union of the wound is to be sought for. Indeed, it was on this account that I was first led to employ, for cleansing wounds, the iodine water to which I have drawn attention, and which I cannot too strongly recommend for general adoption. A sponge wrung out of this lotion (made with hot water), and held to a wound for a minute, completely checks all oozing of blood, and tends more than anything else, except prolonged exposure to the atmosphere, to the formation of that glaze upon the surface of the wound, which so much conduces to satisfactory repair.

ON THE QUESTION OF REPAIR BY PRIMARY OR SECONDARY ADHESION.

When the surgeon has cleansed the wound, removed what foreign bodies may have been present, and stopped all bleeding, he has to decide upon the means whereby the reparative process may be best helped, and, as a primary point, to determine either the feasibility or expediency of attempting to obtain *quick* or *primary union* of the cut parts, or the wisdom of looking to their repair by the slower *open, granulating process*.

When the wound is of the *incised* kind, the question is not difficult to answer; for it may with confidence be asserted that, with but few exceptions, in all wounds of this description, whether superficial or deep, accidental, or the result of operation, repair by quick or primary union is to be desired, and, what is more, may be expected, if the subject of the wound be healthy, and not too old, and if nature's reparative process be so aided by surgical art as to be allowed to take its course without interference.

The cleaner the cut is, the greater is the probability of its uniting by quick repair; the more ragged, contused, and lacerated the margins of the wound are, the less are the prospects of obtaining primary union, and the less the wisdom of making the attempt; between these two extremes are innumerable gradations. When there is a doubt about the wisdom of making the attempt to secure primary union, in deep contused and lacerated wounds, let the decision be against it, and when the doubt applies to the more superficial or hopeful class of wounds, let it be decided in its favor.

Care must, however, be taken in these, as in all cases, to give up the attempt on the appearance of the slightest local or constitutional symptom, suggesting that, by the drawing together of the parts by sutures, etc., some

retained blood, serum, or sloughing, injured tissue is keeping the part in a state of *unrest* by tending to separate the lips of the wound, and by exciting tension ; or is undergoing chemical change and decomposition, thus threatening the production of some septicæmic or pyæmic blood-condition. For it must be recognized that, whilst in the cleanest incised wound there may be no death of the divided tissues, and consequently no animal matter to undergo chemical change or putrefactive decomposition ; in the contused and lacerated, there must of necessity be more or less destruction. When tissue dies, it must be shed or cast off from the living parts, before the physiological reparative or uniting process can take its course. When this dead tissue has been separated from the living, it ceases at once to be influenced by the vital processes by which it had been built up, kept alive, and eventually cast off ; it consequently becomes subject to the physical laws of all dead matter, and undergoes chemical changes—which mean too often decomposition.

The object of the surgeon, therefore, in the treatment of these cases of wound in which the death of tissue is to be expected, and cannot be prevented, is to neutralize as far as possible the evil influence of its death and probable decomposition ; and this is to be achieved by so dealing with the injured part that the dead tissue may find a free outlet for its discharge, by rejecting all such applications or dressings as are likely to help putrefactive decomposition, and by employing such means and agents as are likely to neutralize its pernicious influence, and in a measure control the process of decay. With these views, therefore, the surgeon should close up such wounds alone as from their cleanness can be expected to heal by quick or primary union, and should leave open all such as from their raggedness and contusion are sure to be attended with more or less death of tissue, providing in these a free vent for all discharges of decomposed material, and employing antiseptic and disinfecting local applications to neutralize the evils of the chemical changes.

TREATMENT TO HELP QUICK OR PRIMARY UNION.

To promote the primary union of a wound the surgeon has six indications to follow :—

- I. To cleanse the wound ;
- II. To arrest all bleeding ;
- III. To effect coaptation of the two divided surfaces of the wound—the deep parts as well as the edges.
- IV. To maintain the wounded parts in a position of immobility, beneficial to the natural process of repair as well as comfortable to the patient.
- V. To secure drainage of the wound by providing for the escape of such dead tissue as may be thrown off, as well as of all fluids that are not required for repair.
- VI. To protect the external wound from all such outside influences as may be prejudicial.

The first two indications have been already considered, viz., the cleansing of the wound and the arrest of bleeding. In all forms of wound, and for every form of healing, attention to these points is most important, but when quick or primary union is to be expected, it is all essential.

COAPTATION OF WOUND.—The coaptation of the two divided surfaces of the wound (the third indication), may be efficiently carried out in superficial or not deep wounds by means of sutures and adhesive plaster separately or

combined. When by the use of trustworthy adhesive plaster the object sought for can be obtained, sutures are not called for; and when sutures are used, the form of suture that carries out the object in view in the simplest way is the best.

Interrupted Suture.—When the wound is *superficial*, the sutures need not be introduced deeply; but when the wound is *deep*, the practice of bringing the edges of the wound and not the deeper parts together, is fraught with danger, since the repair by primary union which is looked for cannot take place, and between the separated surfaces of the deeper parts of the wound, blood, serum, or inflammatory fluids will collect and give rise to trouble. Hence in deep wounds the sutures should either be all introduced deeply, or deep as well as superficial sutures should be employed. The *interrupted* is the most useful form of suture (Fig. 225), and it is applicable to superficial as well as to deep wounds. In the superficial, it should be inserted with sufficient depth and closeness to bring the surfaces and edges of the part accurately and closely together, and it should be tied with enough force to carry out these objects, but not with more; since to tie a suture as a surgeon would a ligature, is to do harm—the suture cutting rapidly through the strangulated tissues, and in so doing irritating the part instead of helping repair.

In *deep* wounds the sutures must be inserted deeply, as in harelip operations, and introduced well away from the edges of the separated tissues, so that when they are tightened the deeper parts as well as the superficial will be brought effectually into apposition. In some cases deep and superficial sutures may be made to alternate. Superficial sutures should include neither muscle nor deep fascia.

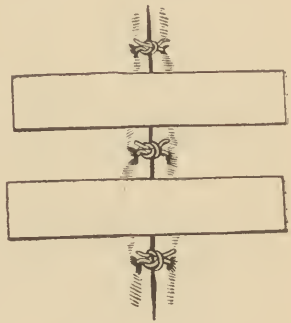
In the majority of cases in which sutures are employed, it is an excellent plan to alternate the sutures with the strapping; a narrow band of the latter, carefully adjusted between the stitches (as shown in Fig. 225), not only materially aiding the adaptation of the edges of the wound, but, if well applied, tending towards the prevention of tension, and towards the immobility of the wounded part, while at the same time it gives important aid in the way of affording local pressure to the deeper portions of the wound. In operations on the breast, the advantages of this practice are well exemplified.

[If *wire* is employed for the interrupted suture, the ends may be simply twisted, or may be passed through a Galli's tube, or a perforated shot which is then clamped with strong forceps. This variety of the interrupted suture is known as the *shot* or *shotted suture*.]

Continued Suture.—The *uninterrupted, continued*, or *glover's suture* (Fig. 226), is valuable in cases of wound of the intestine, as well as in those of the eyelids and face generally; indeed, a clean wound of these parts—superficial or deep—may be so accurately and well adjusted by means of a fine needle and thread as to leave but a minimum of scar.

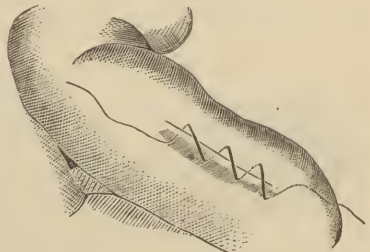
In operations about the lip, the same remarks are applicable, although, in these, care should be observed to introduce the sutures deeply, and well

Fig. 225.



Interrupted suture.

Fig. 226.

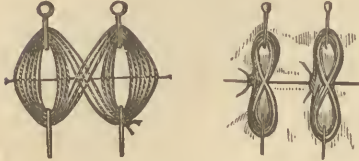


Continued suture.

away from the margins of the wound. In operations for phimosis, in the adult, this form of suture is likewise of great value, not only expediting recovery, but doing much to make the result of the operation more artistic. In these cases the fine carbolized gut suture may be used.

Twisted or Harelip Suture.—The *twisted suture* (Fig. 227) is of value in certain operations on the lips and cheeks, and in other parts where difficulty is experienced in bringing the tissues together, since by its use more force can be brought to bear upon the margins of the wound, and their adaptation can thus be rendered more perfect. This form of suture was in former times the one commonly employed in harelip operations, but it is not so now. I have discarded it in favor of the interrupted suture of silk, silkworm gut, or wire, and employ it only in double harelip operations, or in cases in which exceptional difficulty is

Fig. 227.



Harelip or twisted suture.

experienced in bringing the parts together.

[*India-rubber Suture.*—This is a modification of the twisted suture, introduced by M. Rigal and formerly employed by the late W. J. Atlee, of Philadelphia. An India-rubber ring is slipped over the ends of the pin, instead of the twisted ligature, and serves by its elasticity to lessen the risk of causing undue tension.]

Quilled Suture.—This form of suture (Figs. 228, 229) is applicable where deep wounds have to be well held together along their whole line, and more

Fig. 228.

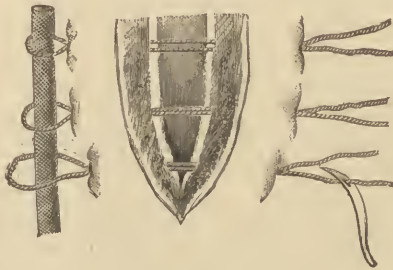
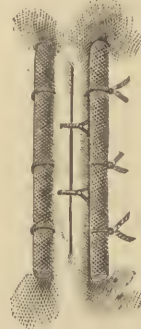


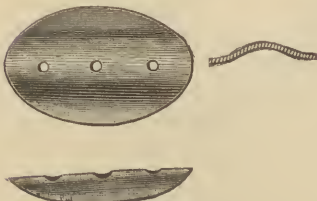
Fig. 229.



Quilled suture.

particularly for a brief period, say two or three days. In ruptured perineum it is certainly of value, combined with superficial sutures (as shown in Fig. 229), but even in these cases the interrupted sutures of silkworm gut, introduced well away from the margins of the wound, and inserted deeply, are probably to be preferred.

Fig. 230.



Button suture.

Button Suture.—This (Fig. 230), which is a variety of the quilled suture, is useful in some amputations, as of the thigh, where the surgeon is desirous of keeping the bases of the flaps together. It is useful likewise in harelip or other lip operations.

Material for Sutures.—With respect to the material used for sutures—silk, wire, silkworm gut, prepared catgut, or horsehair—each is good in certain cases when rightly selected. Where there is little tension on the sutures, silk or wire may be indifferently employed, the amount of irritation excited by one or the other material depending more upon this point of tension, than on any other. I have long ago proved this to my own satisfaction, by testing both forms in the same subject, through a long series of cases. In *plastic operations*, silkworm gut, well softened in water before use, is to be recommended; it holds well, and seems to irritate far less than any other material. In cases of ruptured perineum, and in operations for vaginal fistula and fissured palate, it should always be used. In the latter class of cases, when the soft palate alone is involved, horsehair is good, but it is not strong enough to resist much tension. In plastic operations in which some skill may be called for in adjusting the parts, wire sutures may be selected, since such sutures can be twisted and untwisted with facility, and the surgeon can consequently readjust the margins of the wound, as required, to his satisfaction. Catgut is not a reliable material for sutures, since it is uncertain as to its retaining power, and is apt, when sodden, to yield; it is, however, useful as a suture in holding parts together for a brief period, where there is no tension, and where there may be a difficulty in removing the stitches subsequently. In operations on the penis, it is of special value.

PRESSURE.—The effectual carrying-out of the third indication in the treatment of incised wounds, viz., the coaptation of the two divided surfaces of the wound—deep parts as well as edges—is not however always to be accomplished by means of sutures and strapping, however well selected and applied these may be. Other means are constantly demanded, and of these, *well directed pressure* is the most important; indeed, the value of pressure in the treatment of all wounds is worthy of more consideration than it has received. By it the surfaces of divided parts are kept together, and particularly the deeper surfaces; mobility of the injured tissues is checked, if not prevented; the vessels of the wounded parts are supported; and the evil influence of blood stasis with its effect—effusion—is neutralized: under these circumstances repair is helped, and nature's processes are permitted to go on under more favorable conditions. With this view of the value of pressure, well-applied pads of lint, absorbent cotton-wool, gauze, or sponge saturated or not with some antiseptic drug, should be carefully adjusted over the flaps of all wounds, when such exist, and over the surfaces of others. These pads are kept in position by means of strapping or bandages, aided by splints when the extremities are involved. After the removal of a breast or tumor, the value of a well-adjusted pad, and more particularly of a sponge wrung out of iodine lotion or carbolized water, cannot be too highly praised. After an amputation, the use of a splint, adjusted to the stump, and pressure well applied to the bases of the flaps, not to their edges, should never be omitted.

IMMOBILITY.—The maintenance of wounded parts in a position of immobility, beneficial to the natural process of repair as well as comfortable to the patient, is the fourth great indication in the treatment of incised wounds; and to say the least, this is as important as the preceding, since, if neglected, the benefit that might be expected from efficiently meeting the third indication could not be realized, and the process of repair in the wounded part would of necessity be checked, if not altogether prevented.

To carry out this indication, *immobility* of the wounded part is of the first importance, and its *position* next: the position being always selected with the object of giving ease to the patient, and of preventing pain; of relaxing

the wounded tissues, and so guarding against any tendency to bring about a separation of the edges of the wound, as in cut-throat cases; and last, but not least, of encouraging the return of the venous blood from the wounded parts towards the heart. Thus in wounds of the trunk, the horizontal position is the right one to be maintained, and in those of the extremities, flexion and elevation of the limb; in wounds of the lower extremity, the foot should be kept higher than the knee, and this than the hip; and in those of the upper extremity, the same principles of practice should be followed, the elbow being generally flexed. Under all circumstances, wounded limbs should be fixed upon splints, with the view of immobilizing them, and, as a rule, the limbs should be swung; this practice adds greatly to the comfort of patients, by allowing them to move their trunks without their wounded extremities, and without therefore interfering with repair. It should be added, however, that this question of position ought always to be considered in reference to the *fifth* indication, namely the necessity of providing efficient means for the removal of the superfluous fluids of the part, and for the escape of disintegrated dead tissue which may have to be discharged, or, in brief, for "drainage."

DRAINAGE.—Drainage, or the making of due provision for the escape from the wound of disintegrated dead tissue, with such fluids as are not required for repair, and which if left might prove injurious, is of primary importance in the treatment of all, and more particularly of deep wounds. It should never escape the attention of the surgeon. In scalp wounds, and those about the eyelids, though they may appear trivial, it is of as much importance as it is in the wounds that involve deeper parts and seem more severe; for in the one case as in the other, pent-up fluids not only tend to separate tissues which are intended to unite, giving rise to pain by producing tension, and consequently causing constitutional irritation, but they are prone to excite inflammation in the part, and ultimately to undergo septic changes, which in their turn may give rise to blood-poisoning in the form of septicæmia or pyæmia.

No other than trivial wounds consequently should be completely covered in, and deep ones very rarely. Some corner, and preferably that which is most dependent—some interval between the sutures or strips of plaster—should always be left open for the escape of disintegrated tissues, and of superfluous fluids, such as blood or serum; and where deeper structures are involved, some conducting material or "drainage-tube" should be introduced. The best is a tube of India-rubber, perforated at intervals (as originally suggested by Chassaignac, in 1855), of a size varying with the cavity or wound to be drained; but in some cases a strand of carbolyzed catgut or horse-hair, a roll of gutta-percha skin, or a piece of lint saturated with carbolic or terebene oil, will do as well. In abdominal cases (as after ovariectomy), a perforated glass tube is of great value, while under other circumstances an elastic catheter will answer the purpose. The particular mode of accomplishing the object is of little importance, as long as the object itself is secured.

In using a drainage-tube, however, the surgeon must remember that it is not to be made a seton, and that the sole justification for its use is to secure the free evacuation of fluids from the deeper tissues. For this purpose, it is to be made to dip deeply enough into the wound, but no more; it is not to be made an irritant. The size of the tube is to be regulated by the requirements of the case; several short tubes are often better than a long one. Care is also to be taken that the outer ends of the tubes are left free; when covered, they should be covered but lightly, and then with some absorbent cotton, oakum, sponge, or gauze. As a rule, however, they should be left open. In using the tube, when the end is cut off level with the wound, the outer ex-

tremity should be held by means of loops of carbolized silk, perforating its walls and secured externally by strapping or other means. The tubes should always be introduced at what will be the most dependent part of the wound, when the patient is in the recumbent position; and they should be taken away as soon as they have answered their purpose. When quick or primary union has taken place, they may safely be removed at the end of twenty-four or forty-eight hours; but when suppuration is present, they must be left longer, sometimes even till the cavity has closed.

A drainage-tube should, however, be shortened as rapidly as the progress of the case will allow, the shortening of the tube and the closing of the cavity of the wound from below going on together.

It is to be noted that, at the present day, the use of drainage, whether by tubes or other material, is suggested with the view of *preventing* suppuration in the treatment of deep wounds; whereas in former times, when Chassaignae introduced his tubes, it was for the treatment of wounds and cavities in which suppuration already existed. The value of the principle is, however, equally great in both classes of cases. When carbolic acid is used as a wound dressing, whether as a spray or as a lotion—or when chloride of zinc lotion is employed—the use of the drainage-tube is more necessary than it is when other forms of dressing are employed; since under the stimulating influence of these drugs, there is, as Lister tells us, more effusion of plasma than is to be looked for under other circumstances. Whenever a wound is closed, with the view either of obtaining rapid or primary union, or of converting an open, as far as possible, into a subcutaneous wound, the most careful inspection is called for, to guard against and even to anticipate trouble. In these cases, the wound should be opened on the slightest approach of local tension or overaction, with elevation of temperature and traumatic fever, since this local and constitutional disturbance will probably be found to be due to the retention of some of the fluids of the part that are in excess of what is wanted for repair, and to be susceptible of relief only by the evacuation of such retained substances.

PROTECTION OF WOUND.—The protection of the external wound from all such outside influences as may be prejudicial to the progress of natural repair, is the sixth and last indication for the surgeon to follow; and it is in itself as important as the five which have preceded it, since it includes the use of all means by which the wound can be protected from outside injury, as well as the dressing proper, or covering of the wound.

For purposes of protection, most wounds require a covering, and, when they are on the extremities or other exposed parts, some cradle or other mechanical appliance, to keep off the weight of the bedclothes. In wounds of the face, however, coverings are rarely required, for all surgeons are familiar with the fact that there are no wounds, operative or accidental, that do as well as these, without any external application, provided that they have been carefully brought together and adjusted. Indeed, it is probably from a knowledge of these facts that the "open method" of treating wounds has been advocated. This method cannot, however, be recommended, except for wounds of the face. For some years past I have been in the habit of dressing wounds with dry absorbent lint, or with lint soaked in a mixture of terebene, one part, and olive oil, three parts, and have every reason to be well satisfied with the practice. I simply cover the oiled lint with a second piece of dry lint, and fix the whole with some retentive bandage, room being left in all cases for drainage, either by loosely covering one corner of the wound, which is left open for drainage purposes, or by perforating the lint covering the wound, to allow of the protrusion of the end of the drainage-tube. Cotton-wool

of the absorbent kind, is then arranged about the tube, to absorb all fluids that escape, but not in any way to arrest their flow; since to insert a drainage-tube, and then to smother up its orifice, seems inconsistent practice. When the spray and gauze system (Listerism) is adopted, all the precautions essential for security must be observed, the principle upon which this system is based being one of exclusion not only of air, but of all germs that may be floating in it, which germs are supposed to be the cause of suppuration and of the decomposition of organic fluids. *Wet applications*, and more particularly watery ones, are now seldom used, and cannot be recommended; since it is well known that by moisture, decomposition is encouraged. When they are employed they should be medicated; that is, they should contain some drug which has an influence in preventing or arresting decomposition, or in neutralizing the evil effects of the chemical changes which are sure to take place, either in the contused and devitalized injured tissues, or in the secreted or poured-out fluids, whether blood, serum, or pus. The best of these drugs are the chloride of zinc, carbolic acid, boracic acid, thymol, terebene, iodine, alcohol, the permanganate of potassium, and iodoform.

ON THE SECOND DRESSING OF A CLOSED WOUND.

No fixed period can be named when the first dressing should be removed from, and a second applied to, a wound which is being treated with the view of obtaining healing by quick or primary adhesion. But this is certain; that no interference should be allowed under a week, unless there is some indication, either in the form of local discomfort or pain, or of some constitutional symptoms, such as an increase of temperature with febrile disturbance, to justify the act. In truth, to use a legal phrase, the surgeon should, in all cases, show cause why he should interfere, before he does so, for it is not to be denied that even with the gentlest and most skilled manipulation, there must of necessity be some interference with the reparative process; some slight tearing away of the new reparative material; some taking away of support where support is essential; or removal of local pressure where such is needed; in fact, there must always be some injurious influence upon the healing part, which should not be permitted without a compensating good effect. A wound treated for repair by primary adhesion, if let alone, will probably, under favorable circumstances, heal within the week; and a large wound, such as that made in ovariectomy, in excision of the breast, or in amputation, will heal within two weeks under the best conditions. If it does not, it is because there is something wrong with the patient's general condition, or something wrong in the wound, or more particularly its treatment; for the primary dressing of the wound should have been such as to render early interference with it unnecessary.

To recapitulate, (1) the edges and surfaces of the wound should be carefully adjusted and fixed together; (2) complete immobility of the injured part should be guaranteed by the judicious application of splints, pads, and bandages; (3) the limb or wounded part should be placed in the most comfortable position for the patient, as well as in that which is most favorable for repair; (4) due provision should be made for the effectual drainage of the wound, and care should be taken that the effect of drainage is not neutralized by any external application or dressing; and lastly, (5) such dressings or external coverings should be employed as will protect the wound from external injury, and guard against or neutralize the decomposition of such fluids as may be poured out. A wound, however large, dressed effectually on these principles, will probably not require dressing for a week, or at least not more than the

removal of the absorbent material which has been placed to catch the drained secretions of the wound; and will be found, when dressed, to be well, or nearly well. A wound, however small, dressed ineffectually, will probably be unhealed and suppurating. The nearer the surgeon can approach perfection in his first dressing, the more successful will he be in his practice, and the larger will be his proportion of cures by primary adhesion.

When a *second* dressing is called for, the surgeon should have at hand everything which may be required for the purpose: lint, prepared in size and shape, and steeped in whatever dressing he may have arranged to use; scissors, forceps, bandages, strapping, absorbent cotton, trays, and irrigators, whether in the shape of a can or in that of a dressing bottle. When the wound is large, and water is to be used in quantity, he should have a piece of water-proofing to place beneath the part, and such assistants as may be required. He is then to remove the external dressings, and in doing this, as in every subsequent proceeding, he is to employ the utmost gentleness. He should, however, beforehand place his patient in the most comfortable position he can, and then place himself comfortably; for no surgeon can do his work well if he is in a constrained posture. In removing external dressings, some time is often required, but it must be granted; for when dressings are glued to a wound by blood or secretion, they must be softened with water, or rather medicated water, before they can be taken away without doing harm. Having taken off the external dressings, sent them away, rolled them up, or thrown them into a basin of antiseptic fluid, and having exposed the part with its sutures, and possibly the strapping which was applied for adjusting purposes, the surgeon is then to cleanse the part, and for this object he cannot do better than to use the absorbent cotton, either dry, or wet with the medicated lotion. The sutures should then be cut and withdrawn, care being observed not to drag a long loop of suture, covered with dry secretion, through the tissues, but to cut it off close to the skin through which it will have to pass. When the union of the wound appears weak, or when it is on an early day after the first dressing that the second is being made, support should be given to the tissues by the application of a piece of well-adjusted strapping, as each suture is taken away; a second and third, or more pieces, being successively applied as the dressing proceeds. If the sutures are not irritating, and the wound has not healed well, they should be let alone. In deep wounds, the surgeon should never be in a hurry to remove sutures, whether they are irritating or not, for if he remove them before good repair has taken place, the wound will gape, and under such circumstances the prospect of securing repair by primary adhesion will have disappeared; and even when the sutures are cutting through from overstretching of the part, it is, as a rule, well to let them alone as long as they have any influence in holding large flaps together, or in preventing wide separation. At the same time, all sutures should be removed as soon as they have answered the purpose for which they were introduced, or when all hope of their fulfilling it has passed away. The removal of a stitch from a wound which is suffering from the irritation caused by tension, and possibly from some collection of fluid, is always wise.

When splints have been used to support and to insure the immobility of wounded parts, they should not be removed unless for some urgent cause. It is to be assumed that they were so applied at first as to allow the surgeon to remove, when necessary, the external dressings without interfering with them. With the same view, of preventing the necessity for its early removal, a splint should be covered with some protective such as gutta-percha, or oiled silk.

To complete the second dressing, a fresh piece of lint soaked in the terebene and oil, or other selected application, is to be laid on the wound, and

the parts covered as after the first dressing, the surgeon taking care to see that efficient means are employed for the external protection, immobility, and good drainage of the wound.

SUBSEQUENT DRESSINGS.—The third and later dressings of a wound must be governed by the same principles which have been laid down for the second; and they are to be conducted in the same quiet, gentle, and yet decided manner. They are not likely to be very numerous, should primary adhesion be obtained, but when that hope has fled, they must be carried out daily, or possibly more often: they will, however, then have to be conducted on very similar principles, although with different objects.

CONTUSED AND LACERATED WOUNDS.

These wounds, from a clinical point of view, should be classed together, since in both, the edges of the wound are as a rule so injured as to be irregular and the seat of ecchymosis; and since in both, before repair can practically begin, death of some of the injured surface, or of some of the surrounding subcutaneous or other tissue—the margins or flaps of the wound—is to be expected. In the *contused* wound, the breach of surface is brought about by a blunt instrument, moving with a greater or less velocity; and the extent of bruising or contusion of the soft parts in the neighborhood of the wound, will be found to vary with the size of the instrument which inflicted the injury, and with the force of its impact. When the wounded body is large, the extent of injury will be proportionate; but when the velocity is great, the area of contusion around the edges of the wound will be lessened, as the extent of wound will be increased. The best examples of contused wounds of all kinds are met with in military surgery, as caused by the impact of spent balls or fragments of shell. *Lacerated* wounds are generally brought about by a tearing or biting process, and are characterized by great irregularity of the lacerated tissues from the skin downwards; this irregularity depends much upon the different degrees of elasticity of the parts torn—skin, arteries, muscles, and tendons, all behaving differently when submitted to a lacerating force.

In *contused* wounds, the area of injury generally extends far beyond the area of the breach of surface, and when death of tissue follows it may spread widely. In *lacerated* wounds, the area of injury is generally more localized; though this remark is not applicable to wounds in which muscles and tendons are involved. When, for instance, a finger or thumb is torn off, the tendons connected with the injured part may separate at their muscular origins in the forearm.

HEMORRHAGE FROM CONTUSED AND LACERATED WOUNDS.—In both contused and lacerated wounds, there is less primary hemorrhage than there is in those of the incised variety; the *contusing* force so affects the vessels at the seat of injury, as to favor the coagulation of the blood about their open mouths, or so ruptures the inner and middle coats of the bruised vessels as to mechanically interfere with the flow of blood, and thus encourage the formation of a clot by which the lumen of the injured artery may become occluded; while the *lacerating* force likewise irregularly divides the different coats of the vessel and its sheath—even in the case of a large artery—and thus favors the coagulation of the blood at the seat of laceration. This temporary plug of the vessel is generally sufficient to close the orifice until nature's permanent hæmostatic processes have had time to act and to seal the vessel.

Secondary Hemorrhage.—In *contused wounds* there is, however, a far greater proneness to *secondary* hemorrhage than is met with in any other form of wound, the contusing force often primarily injuring an artery, but not opening it, yet so destroying the vitality of its coats as to set up an inflammatory, sloughing, or ulcerating process, which in its turn may be followed by the formation of an aneurism, a wound, or a rupture of the vessel, and, as a consequence, by secondary hemorrhage. Contused wounds are consequently of a more dangerous character than lacerated wounds.

SUBCUTANEOUS CONTUSED WOUNDS, that is, severe contusions of soft parts from the impact of blunt instruments, the passage of a wheel over the part, or other force, without breach of surface or exposure of the injured tissue, are at times more grave than those in which a breach of surface exists. This is best seen by studying the effects of such kinds of injury upon the abdominal and pelvic viscera, an unbroken and apparently uninjured outside surface often covering a fatal subcutaneous rupture of a solid viscus, or a laceration of a hollow one; but the same fact may be also well seen in severe injuries to extremities, where from a contusing force an artery may be stretched, bruised, or lacerated, large veins may be torn across, nerves injured, and muscular and other tissues irreparably damaged.

The amount of harm which deep tissues may have sustained in any given injury, can therefore only be estimated by a correct appreciation of the force which has been applied, and of the position and condition of the injured part at the time of its reception. It can never be made out by simple inspection of outside appearances. Such injuries always demand great care in their treatment.

TREATMENT OF CONTUSED, LACERATED, AND OPEN WOUNDS HEALING BY GRANULATION.

The principles upon which the treatment of contused, lacerated, or open wounds is based, are the same that have been laid down and explained in considering the treatment of incised wounds, though they may require some modifications in their application, on account of the altered circumstances in which they have to be carried out. For example, in a deep *lacerated* wound, the surgeon will have to cleanse it and arrest bleeding, as in an incised wound; but he will not have to adjust the divided surfaces and apply sutures, in the same careful way that he would be called upon to do if “quick union” was to be looked and worked for; and he will remember that this change of practice is demanded in contused and lacerated wounds, because there must of necessity be more or less sloughing or molecular disintegration of the lacerated tissue and contused parts around, and that, as a consequence, it becomes a matter of primary importance to leave the wound open, for the free discharge of all such tissues as may have been destroyed, or may die, as well as for the evacuation of the fluids which must be poured out in the reparative process.

He will, however, in this class of cases as in the former, secure immobility of the wounded part, and fix it in the position which will be easiest to the patient and most conducive to the healing act; and he will not forget to make the fullest provision for the drainage of the wound from its lowest depths. He will, moreover, have to be additionally careful in the dressing of the wound, since it is an open one, as from such, septic matter is more rapidly absorbed before the process of granulation has commenced, and as such a wound is afterwards readily influenced by external applications. In *one* instance, the wound may have to be regarded and treated as an open one from the first,

the excavated surface being filled in with a light dressing, as if it were a surface wound; in *another*, where there is a tendency for the surface edges to fall together and unite, and where this union would be injurious by interfering with the free evacuation of such discharges as are to be looked for from the wound, or with the escape of sloughs of destroyed tissue, the dressing may have to be inserted between the lips of the wound, or even down to its bottom; for it is essential, in these cases, that the wound should not be closed, and that a free vent for all fluids should be maintained; while in a *third* case, the provision for free drainage may, from the position of the wound, be so imperfect, that a special opening (counter-opening) may be called for, at the most dependent situation of the injured parts, or at some other position which the ingenuity of the surgeon may suggest. Under all circumstances, wounds such as these, which are not expected to heal by quick union, should be so dressed as to allow of the free egress of all secretions without disturbing the parts. The primary dressing which I am in the habit of employing for fresh wounds is, as already mentioned, lint or absorbent cotton, saturated with a mixture of terebene one part and olive-oil three parts, the saturated dressing being covered with another layer of dry lint or cotton. Where a wound has to be lightly filled with some dressing, I use the absorbent cotton saturated with the same terebene and oil, and a light pad of the absorbent cotton applied over the whole and held in position by a retentive bandage; and even when a drainage tube or drain orifice exists, the same light dressing is applicable, since it absorbs such fluids as may escape externally, and in no measure tends to restrain their flow. In some cases, a soft sponge which has been wrung out of iodine or carbolic lotion, is a good substitute for the wad of absorbent cotton.

In cases of more severe wounds, where a free flow of fluid is to be expected, and where the danger of its retention would be great, the opening of the drainage tube or discharging orifice should be left free. In the dressing of all stumps, and most deep incised or lacerated wounds, this practice should be followed, since it enables the surgeon to bring the parts more accurately together than would otherwise be advisable, and to keep them quiet, and in apposition, by means of pressure applied over the whole of the wound, except the drain orifice. This method has likewise the great collateral advantage of allowing the surgeon to leave the wound undisturbed for some days, probably for a week, and to postpone his first dressing till a period when nature's reparative process will have had time to shut off the wounded part from the deeper tissues, and to do much in the direction of its repair. There should always be a reason for dressing a wound: dressing as a routine practice is not to be commended; it should always be deferred till it is required.

Wounds must be kept *clean* under all circumstances, and free from every septic risk—contused and lacerated wounds particularly; but a wound must be kept *quiet*, if repair is to go on steadily, and this quiet is as necessary for the lacerated as it is for the cleaner kinds of wound. A form of dressing such as has been described, has advantages over many others, for it renders early and frequent dressings of the wound unnecessary.

PUNCTURED WOUNDS.

Punctured wounds, when made with sharp-cutting instruments, are deep *incised* wounds, and when with blunt or wedge-shaped tools, deep *contused* wounds. They differ from other incised or contused wounds in their depth, and in the uncertainty which, as a consequence, follows, with respect to the tissues that are wounded; but above all in the difficulties which are always

experienced in providing for the efficient evacuation of blood, serum, or broken-down tissue, where drainage is needed. These difficulties are clearly due to the external orifice of the wound being but small in proportion to the depth of the penetration.

When a punctured wound is made with a clean sharp instrument, into the healthy tissues of a healthy subject, harm need not be anticipated; indeed, quick repair may be looked for with almost as much confidence as if the wound were of the more simple incised kind. This observation is confirmed by the general experience of all who practise subcutaneous surgery, although when large vessels or nerves are wounded, troubles may arise, which are not lessened by being hidden. When, however, a punctured wound is made with a blunt and wedge-shaped, or possibly a dirty instrument, the wound will be of the contused kind, and, being so, will partake of the disadvantages of such wounds in addition to those which appertain to it in itself. It will consequently—on account of its being contused—be associated with death of some of the injured tissues, for the escape of which due provision will be required; and it can only be expected to heal by the second or third intention. On account of its being a punctured wound, it will moreover exhibit the difficulties of providing for proper drainage, under circumstances in which efficient drainage is particularly called for. As a consequence of these conditions, special dangers are developed in punctured wounds, which can only be rightly met by a full recognition of their nature, and of the requirements essential to their prevention.

When tense fasciæ are punctured—such as are found in the palm of the hand, sole of the foot, and scalp—or when deep muscles, bound down by fasciæ, as in the thigh, are involved, and secondary inflammation ensues, the case is often very serious. Punctured wounds of cavities are worse than those of the soft parts covering bones, in the same way that all other wounds of those parts are graver; as well as from the fact that in punctured wounds there is more uncertainty as to the nature of the parts wounded, and that, with this uncertainty, there are, of course, less clear indications for treatment.

TREATMENT OF PUNCTURED WOUNDS.—There is no form of wound which the surgeon has to treat, in which a greater uncertainty exists as to the result of treatment than in the punctured; and all punctured wounds should be dealt with therefore with the greatest caution. When the wound has been inflicted with a clean, sharp instrument, and when it is treated as it should be—as any other clean wound—with moderate compression and the application of a dry or antiseptic dressing, such as terebene and oil—and is then left protected and at rest, to heal—there will be every prospect of repair going on as satisfactorily in a wound of accidental origin, as in those which surgeons daily inflict in their operations of tenotomy and osteotomy. Even when the wound is of the contused kind, and repair by quick union is not to be looked for, the surgeon is probably justified in employing the same means, although in doing so he must be keenly alive to the risks of the case and the dangers of the practice adopted, and must be ready, on the appearance of any swelling, pain, heat, or redness, and more particularly of any elevation of the bodily temperature, or fever, to remove all dressings, expose the wound, and adopt such means as the nature of the case will allow to give vent to the pent-up fluids of the part, and thus relieve the local irritation caused by their retention; to put an end to tension of the tissues; and to do what may be best to check the further absorption of substances which, if not already decomposing and undergoing chemical changes, may soon be so, and give rise to septiciæmia and blood-poisoning.

In one case, this may be done by re-opening the external orifice of the

wound; in another, by enlarging it; whilst in a third, a fresh opening may be called for in the most dependent part of the injured region. Under all circumstances, however, the object is the same: to give vent to the pent-up fluids of the part, whether inflammatory or otherwise. At the same time, the injured part should be raised, to encourage the venous circulation through the limb, and, as a rule, pain will be relieved by the local application of warmth and moisture, whether in the form of a compress or in that of a fomentation, mixed with sedatives, such as opium or poppy decoctions. Cold rarely gives comfort in these cases, and it certainly does no good towards checking inflammatory action, since that which is clearly occasioned by retained secretions, is only to be relieved by their removal. For the same reasons, leeches are rarely applicable, although in a plethoric and vigorous patient they may be permissible; but even in such, the judicious use of small and repeated doses of sulphate of magnesium has a more powerful effect for good with less risk of doing harm.

In the treatment of all punctured wounds, the surgeon has only to remember that, as their danger consists in the difficulty of providing efficient drainage, so their treatment turns upon this deficiency being remedied; and the surgeon who, on the first appearance of local or general symptoms indicative of the presence of retained fluids, makes an outlet by one or other of the means which have been suggested—even when the outlet is only for the escape of pent-up serum—will be more successful than another who, from timidity or other cause, leaves the case to run its course, till a large inflammatory abscess has formed from the irritation caused by the fluids which should have been evacuated. In all punctured wounds which do not heal quickly by primary union, and in which secondary inflammation occurs, with its necessary effusion, it is the surgeon's duty to find an outlet for the fluids of the part as soon as the fact of their retention is clear. The artificial formation of a free vent for these fluids will be followed by relief, both locally and generally, and will almost always save tissue; whilst delay in adopting this practice is not only locally deleterious, but may even prove dangerous to life. When thecæ of tendons, fasciæ, and fibrous coverings, as of bones, are involved, the necessity of adopting this practice is more important, if possible, than when the softer tissues are implicated; and an incision into the deep parts for the evacuation of even simple serum, by relieving tension, will often prevent the extension of the inflammation, and prevent destruction of tissue.

TOOTH WOUNDS.

Tooth wounds are usually punctured, and rarely other than contused. They may, as may all other kinds, prove to be poisoned wounds, but to these I do not refer. They differ widely in their character; and whilst one case may appear as a simple, clean, punctured wound, another may exhibit all the worst features of the contused or lacerated variety. They are to be dealt with as punctured or contused wounds, each case being treated on its own merits.

TREATMENT OF AN OPEN OR GRANULATING WOUND.

When a wound is granulating, and consequently suppurating, it should be kept clean, as other wounds, and it should be dressed with such a material as may be adapted to protect the granulations from outside injurious influences, and to allow the cicatrizing process to go on without hindrance. The granulations themselves should never, for purposes of cleanliness, be touched

by any coarse material object harder than a camel's-hair pencil, but should be washed by means of a stream of fluid allowed to flow either from the dressing irrigating bottle (see Fig. 208, page 26), or from the irrigating apparatus (Fig. 209), and the washing fluid should be water containing some of the antiseptic salts or minerals to which reference has already been made. In my own practice, iodine water is generally used. It matters little whether the wound be superficial or deep, since a like practice is called for in either case, though where the wound is deep, and where there may be some collection of pus or other fluid, the ingenuity of the surgeon may be taxed to meet the requirements of the case. As a rule, where a drainage-tube is used, the washing out of the cavity can well be effected through it; and where it is not, the end of the tube which is fixed to the piston of the irrigating bottle answers every purpose. In every case, the wound and cavity must be well cleansed with an antiseptic solution, and this cleansing process must be performed with gentleness and efficiency, in order that, on the one hand, the granulations, whether of the surface of the wound or within the cavity, may not be bruised or otherwise injured, and on the other, that no retained secretion may be left behind to irritate and distend the tissues, or to undergo decomposition.

When the granulating process is not of a healthy type, and when the granulations show either deficiency or excess of power, or some morbid action, medicated lotions and constitutional treatment may be required, to which attention will be directed on another page.

TREATMENT OF WOUNDS TO PROMOTE HEALING BY SECONDARY ADHESION.

As in the treatment of a fresh wound to obtain "quick or primary adhesion," the surgeon has simply to cleanse the wound, after arresting bleeding, and to bring the two surfaces into close apposition by the simplest means, and keep them so; thus, in the treatment of a case in which healing by secondary adhesion is sought for, he has simply to bring together the two granulating surfaces, cleansed from all impurities, by such means as are suggested by the special requirements of the case, and to leave them to unite. In harelip or other lip operations, where quick union has been missed, and this secondary adhesion is sought, it may be obtained by the introduction of deep sutures, or even pins; in deep flesh wounds, or after operations, as on the breast, by means of strapping, well applied; and in stumps, after amputations, by means of splints, pads, and bandages. In all cases, the immobility of the part treated is subsequently to be rigidly attended to, and time must be given for union to complete itself before the dressing is disturbed.

SPECIAL MODES OF TREATING WOUNDS.

To estimate correctly, with the light of our present knowledge, the value of any special method of treating wounds, it is necessary to keep constantly in mind the six points to which attention has been directed, since these points are essential principles of practice which should be followed under all circumstances. Indeed, so essential are they, that the value of any special method of treating wounds may be tested by them, and the method regarded as good, bad, or indifferent, according to the measure or degree in which it fulfils the requirements enumerated. (See page 28.) A mode of dressing which satisfies all these requirements or indications, in a simple and efficient way, must be regarded as perfect; and a mode which embodies in itself the greater number

of these requirements, should be regarded with greater favor than another in which these requirements are less efficiently fulfilled.

With this standard of comparison ever prominent, I will now proceed to consider the more important special modes of treating wounds.

TREATMENT OF WOUNDS BY OCCLUSION. (*The Smothering System.*)—This was without doubt the favorite method of dressing fresh wounds among the older surgeons, and in proof of this it is only necessary to refer to the classical works of John Bell, to read how the processes of *mundifying*, *digesting*, *incarnating*, and *cicatrizing*, were carried out. This method was doubtless the outcome of much observation, and was based on what was seen daily in the healing of the wounds of animals by one of the natural methods of repair, that of scabbing.

This mode of healing, under a scab, writes Paget, "is the most natural, and, in some cases, the best of all the healing processes. Very commonly, in animals, if a wound be left wide open, the blood and other exudations from it dry on its surface, and, entangling dust and other foreign bodies, form an air-tight and adherent covering under which scarring takes place, and which is cast off when the healing is complete. The exact nature of the process has not been watched, but it seems to consist in little more than the formation of cuticle in the wounded surface, and it has the advantage that, as no granulations are produced, there is little or no contraction of the scar. In man the same process is less frequent; it is more apt to be spoiled by inflammation producing exudations under the scab, which either detach it or prevent the healing of the surface beneath it. Sometimes, however, the blood shed from a wound coagulates and dries on it, and remaining as a scab, permits healing under it; or, if this do not happen, a similarly effective scab may be formed by the serous fluid or lymph by which the surface of an exposed wound usually becomes glazed; or, more rarely, the pus of a granulating wound may scab, and sound healing take place beneath it."

"To obtain healing under a scab, if the wound be recent, the blood and exuded fluids, or, if it be granulating, the pus, should be left exposed to the air till it dries on the wound, adhering to the edges and surface, and completely excluding them from the air."

There seems, however, to be a proneness to inflammation "which makes the healing under a scab precarious and less generally attainable than one could wish it. No morbid exudation should take place under a scab once formed; everything of the kind painfully compresses the wound and retards its healing."

Such is the mechanism of healing under a scab, and such are some of the methods by which it can be brought about. In Sir Astley Cooper's time (1820 to 1840), with the same object, wounds were often sealed with lint or other material saturated with blood, and in more recent days they have been covered with collodion, alone, or applied on linen; with colloid styptic; with tannin in powder; with dry earth; with Peruvian balsam, or friar's-balsam; with cotton-wool, medicated or otherwise. In some country districts, coal-tar is used for the same purpose, and with the same view. Chassaignac's arrangement, by which a wound was hermetically sealed from the air by consecutive layers of plaster covered in with charpie or cotton-wool, has also been employed. The object of each variety of this form of dressing is the same, viz., the complete exclusion of atmospheric air, and in each an attempt is made to place an open wound as much as possible in the position of one which is closed or subcutaneous.

Cotton Dressing.—In recent times, this method has attracted attention under the form of the "cotton dressing," which was introduced in 1853 by Burggraeve, of Ghent, and advocated by Ravoth. In their hands, it was carried

¹ Article on Wounds. Holmes's System of Surgery, Second edition, vol. i. pp. 636, 643. London, 1869.

out by the immediate application of splints, thickly padded with cotton-wool, to the wound and injured limb, and by then not interfering with the injured part for four or six days. If there was at the end of this time neither inflammation nor suppuration, and if there was a firm scab, the wound was let alone, and only the surrounding wool was removed. If suppuration was present, the wound was dressed with cerate. This method has been described by Schultes as the methodical application of so-called healing by scabbing, extended to large wounds.

Dr. Gräff uses cotton-wool and tannin, the latter being spread over the wound in a layer as thick as the back of a knife; he leaves the dressing untouched for from four to fourteen days. He and Fleck, of Dresden, regard tannin as a simple and cheap antiseptic and disinfectant, and as an unirritating hæmostatic. Both surgeons advocate this method of treating wounds in military surgery.

Alphonse Guérin uses cotton-wool with the view of filtering the air from germs before it reaches the wounded surface, and he applies the wool by smothering the wounded part or limb with many layers, and leaving it undisturbed for twenty-five or thirty days, unless some extraordinary complication should arise—for the occurrence of which a close watch is always kept—to induce him to remove it. Before he applies the dressing, he washes the wound with camphorated alcohol, or carbolic acid, and, in an amputation, introduces the wool between the flaps. When the dressing is removed, there is generally a healthy granulating surface, with a little sweet pus covering it; and the granulations, in the case of a stump, have probably driven out the cotton-wool. This method has the advantage of giving rest to the wounded parts; the gentle and elastic pressure exerted by the wool is also beneficial; as is likewise the constant temperature maintained, and the freedom from pain which is the result of these conditions.

Ollier employs the same dressing as Guérin, but he, in addition, sprinkles the wadding with carbolic acid. According to either plan, the dressing is a close one, and is based on occlusion of the part from air, with antiseptic intentions.

Summary.—If we bring this method of treating wounds, by “occlusion,” to the test laid down at the commencement of this section, it will be found that it fairly well fulfils three out of the last four essential principles of practice, but fails entirely in the most important—the fifth—that of drainage. That is to say, it includes the careful adaptation of the surfaces of the wound, insures rest and immobility of the part for some days, and provides for the protection of the wound from outside influences, and for antiseptis, but it fails entirely in making the smallest provision for drainage. So that, as Syme cleverly expresses it,¹ “there can be little difficulty in perceiving why the sealing up of wounds should be the most certain means of keeping them open.” Under these circumstances, the conclusion is clear, that, whilst this may be a safe and wise practice to adopt in small or superficial wounds, it is a risky and somewhat dangerous method to follow in the treatment of those which are deep or complicated, unless very closely watched. It should never be employed in any case in which the wound is more than superficial, unless the probability of the part healing by immediate union can with good confidence be maintained; and it should never be employed at all, unless the surgeon, carefully watching the temperature of the patient and the local and general symptoms of the case, is prepared to at once expose the wound if necessary, and to evacuate any pent-up fluid that may be present.

¹ *Lancet*, March 31, 1855.

For my own part, whenever I seal a wound with the hope of securing a good result by allowing the parts to heal quietly as in a subcutaneous or closed wound, I never do more than seal it with lint soaked with blood or friar's-balsam, and I take good care to leave the parts otherwise well exposed to observation, in order that I may, if warned by the appearance of any local symptom, such as swelling, heat, or pain, or of any general symptom, such as increase of temperature, or fever, remove the scab, real or artificial, and give free vent to the pent-up fluid. I moreover never apply the practice to any other than a very clean and recent wound.

As a general mode of practice, this method of treatment by occlusion is not to be advocated; in exceptional cases, it may be employed, but then only with extreme caution. In most deep and complicated wounds, it should be rejected. It is only applicable in the very earliest treatment of wounds.

OPEN TREATMENT OF WOUNDS. (*Treatment by Exposure*).—This method was first systematically carried out by a Vienna surgeon, named Vincenz von Kern, in the beginning of this century, and more recently by Bartscher and Vezin, in 1856, and by Burow, in 1866. These German surgeons were led to adopt this mode of treatment by careful observation of the healing process in wounds, and more particularly of the bad results which followed the ordinary methods of dressing by occlusion as then employed in Continental towns, by the use of bandages, charpie, lint, etc. The latter system of dressing wounds, or what has been described as the "smothering method" in which no air could get in, or fluid get out, gave way to the former or "open method," in which the free access of air was the main end sought for, and drainage the second.

The success which attended this practice was moreover considerable, since Bartscher and Vezin had only three deaths out of thirty amputations, and Burow three out of ninety-four.

The method, nevertheless, did not make headway, and it does not seem to have been followed as a rule of practice by any surgeons except Mr. Teale, of Leeds; Professor Humphry, of Cambridge; Dr. R. W. Krönlein, of Zurich; and some members of the Surgical Society of Moscow. The former surgeons in 1858 and 1860, and the latter in 1872, and the Moscow Surgical Society in 1877, have given their respective experiences and conclusions in regard to this method of dressing. [Prof. J. R. Wood's "open method" of treating stumps, may also be considered as a modification of this mode of practice.]

Von Kern's practice consisted in freely exposing the wounded surfaces to the air, and simply keeping the edges of the wound in position by means of sponges. Vezin employed no means for uniting wounds. Burow used sutures, but in such a way that they could be readily loosened in case of distension. Humphry, in 1860, wrote:—

"It is well known that wounds of the face commonly heal up, in their whole length, by first intention. This is due, in great measure, to the vital qualities of the parts, and in some degree also, I apprehend, to the fact that they are usually exposed to the air, their edges being held in contact merely by sutures. For some years we have adopted this plan after amputations and all, or nearly all, other operations. The integuments are united by sutures placed at intervals of about an inch, and the wound, as well as the adjacent surface, is left quite exposed to the air; no plaster, bandage, or dressing of any kind, being placed upon it. . . . All the irritation, the galling pressure, the retention of heat, and other inconveniences resulting from bandages and plasters, are thus avoided. The edge of the wound and the surrounding skin being uncovered, the eye can take cognizance of what is going on; and we can cut a stitch here and there, when required, can keep the part clean, or take other measures without difficulty. Forasmuch as no dressings are applied, there are none to be re-

moved. The suffering which used to be caused by the dressing of wounds after operations is got rid of. In many cases I do not touch the wound, except for the purpose of removing the sutures, from the day of the operation. . . . We decidedly have more frequent union by first intention than when we were in the habit of applying dressings to the wound. . . .

"If suppuration takes place, an early and free vent should be afforded to the pus, by cutting the stitches and opening the wound; and care should be taken to keep the wound clean. . . . Large open wounds—that is, where portions of the skin have been removed, so that the edges cannot be approximated—are in our hospital [Cambridge], not unfrequently, left exposed to the air, without any covering. A dry crust or scab forms upon them, beneath which cicatrization goes on, and we find that the healing often proceeds more quickly in this way than when the part is kept moist and the products of the wound are continually flowing away into the poultices or dressings."¹

Krönlein tells us, after analyzing six thousand cases, that the open method has proved superior to all others, and demonstrates that the mortality of amputations, which by former methods had been 51 per cent., fell by the open treatment of wounds to 20 per cent.; and Rose, who is the present director of the *Clinique* at Zurich, follows Krönlein. He exposes all his wounds to a free current of air, which is maintained by means of open doors and windows. He regards stitches and bandages of all kinds as interferences to be avoided, and trusts to *absolute rest* of the part, after *careful arrest of bleeding*; to provision for *thorough drainage*; and to *scrupulous cleanliness*. The wounded limb in an amputation is kept in one position, on a cushion so protected by mackintosh that the discharges may easily escape into a vessel placed to receive them.

Some of the practitioners of this system are somewhat inconsistent, since they advocate the frequent ablution of the exposed wound with carbolyzed water, or its protection by pouring over it the balsam of Peru; and C. Thiersch adds that whether the wound lies quite free, or is covered with a piece of oiled silk, or with a water compress, cold or warm, does not appear to be of importance, if only free escape of the secretions is not prevented thereby; we may also, he says, add irrigation without changing the character of the dressing, as practised by Bardeleben, and the permanent water-bath may also be of use. Thiersch moreover adds that in cases of compound fracture and gunshot injury—since the free escape of secretions is one of the most important points in their treatment—wounds may be enlarged by incisions, abscesses opened, counter-openings made, and even free openings effected into wounded joints, or resections practised.

The conclusions of the Moscow committee are also favorable to the practice, and may be condensed as follows: The essential feature of treatment by *aeration*, as this committee calls it, consists in avoiding all local appliances for excluding air, and in placing wounds in conditions favorable for free and direct contact with the atmosphere. Lint and other such substances should never be used. Repair by primary union should always be sought when possible. Catgut ligatures and metallic sutures should be employed. The advocates of this system believe that the "Lister dressings" are injurious, but that the antiseptics employed counteract the baneful effects of the coverings.

Summary.—The results of this open treatment are evidently satisfactory, and, judged by the essential points to which attention has been directed, the open treatment of wounds may be advocated; for it includes careful adaptation of parts after arrest of all bleeding, and due provision for thorough

¹ British Medical Journal, Oct. 27, 1860.

drainage; but, on the other hand, it takes little care to guard against mobility of the wounded part, and disregards antiseptic applications and precautions. This neglect is, however, probably due to the justifiable impression that if drainage be provided for, there will be in the deeper parts no retained dead tissue or fluids to decompose or undergo chemical change, and that a free current of air upon the surface of the wound is the best guarantee against septic changes of its fluids. Indeed, Professor Humphry clearly indicated this when he described how large open wounds, by this system, healed by scabbing more quickly than when the part was covered and kept moist. Some of the advocates of this system believe the open treatment to be more adapted to wounds in which union by *secondary* adhesion is to be expected, since they assert that, if an open wound be maintained in a condition of perfect freedom from all irritating causes, such as foreign bodies, dirt, and decomposing elements, granulations will form, and that suppuration is not an essential part of their formation.

For my own part, after a careful review of the whole question, I must regard the open treatment of wounds as being far superior to any other in which due provision is not made for perfect drainage; but at the same time, I fail to see its advantages over some others, and more particularly over that which I adopt, in which all the advantages of the open system are secured, and in which, in addition, the wounded part is effectually guarded against mobility and external injury, while, at the same time, due provision is made, by means of a light antiseptic dressing, against the possibility of any septic changes taking place on the surface, as well as in the deeper portions of the wound. The recent investigations of Pasteur tend greatly to support the advocacy of this open dressing, since he claims to have proved that germ influence is weakened by contact with the oxygen of the air, and that "it is the oxygen of the air which weakens or extinguishes germ virulence."¹

TREATMENT OF WOUNDS BY IRRIGATION.—This must be regarded as only a variety in form of the open method, since its essential advantage consists in the cleansing and thorough draining of the wound from all secretions and impurities. It is carried out by means of a can of water or medicated lotion, so placed above the part to be irrigated that the fluid can be conducted by a tube, as a gentle stream, or, what is better, by means of worsted threads, in rapidly falling drops, upon the exposed and wounded part, the limb being fixed upon a splint, with a pan beneath to catch the fluid as it drains away.

In gunshot wounds of limbs, and in sloughing or unhealthy stumps, or wounds, this mode of treatment is very satisfactory. It has been employed in Guy's Hospital for a quarter of a century, and can be recommended. Es-march speaks highly of it in military surgery.

TREATMENT BY WATER-DRESSING, WITH AND WITHOUT ANTISEPTICS IN SOLUTION.—In 1825, the late Mr. Syme published a paper² in which he pointed out the evils of such old methods of dressing wounds as those of mundifying, digesting, incarning, and cicatrizing, and recommended that wounds should be lightly dressed, after their edges had been adjusted and well brought together with stitches. To this surgeon, in connection with Mr. Liston, may be probably attributed the introduction into British surgery of the use of water-dressing for wounds generally. The practice was very rapidly taken hold of and adopted, every thoughtful surgeon having recognized the evils that attended the methods in which wounds were smothered with masses

¹ Remarks before the Académie de Médecine, *Lancet*, Nov. 6, 1880.

² *Edinburgh Medical and Surgical Journal*, vol. xxiv. p. 52. July. 1825.

or charpie, lint, or other material, and left to heal as best they could, under cover of these masses of dressings saturated with blood, serum, or pus. The practice, moreover, was simple and cleanly, and, when perfected, was comfortable to the patient to whom it was applied; that is, it became so, as soon as the value of a piece of oiled silk, or thin gutta-percha tissue, applied over the wet lint, was recognized, the wet lint before this improvement having soon become dry, and what might have been at first a wet dressing, having been thus converted into a dry one. The water-dressing likewise soon took the place of poultices, for by one, as by the other, warmth and moisture were applied to the wound.

In 1835, M. Josse, a hospital surgeon of Amiens, published a book on the use of cold water in surgical dressings, and advocated its use, *first*, as a trustworthy and efficient means for the control of inflammation in parts not wounded; and *secondly*, as a dressing for wounds.¹

If we had the choice, he says, referring to the treatment of the first class of cases, in which there is no wound, "it might be established as a general principle that we ought to employ water by affusion with a continual stream, but the nature of the parts, or of the disease, may prevent this, and oblige us to recur to another method; thus, linen moistened with water, and renewed without ceasing, may to a certain degree prove a substitute for the affusions, but this mode requires much attention."

He subsequently describes his own method: "A vessel with a cock near its base is filled with water, and placed upon a narrow and high table, near the patient's bed, in such a position that it shall be about a foot and a half above the diseased limb, beneath which a cerecloth is spread, intended to guard the bed, and facilitate the flow of the water, which is received in a bucket, placed near for that purpose, and into which the extremity of the cerecloth descends." "The diseased part should then be placed in the most convenient position; it should be lightly covered with compresses; an additional piece of linen should surround the cock by one of its extremities, while the other is extended over the highest point of the apparatus. This is destined to prevent the water from falling with all its weight on the diseased part, and rather to disperse it over a larger surface."

I have described this method of using cold water fully, for it is one now recognized as the treatment by "irrigation;" which, whether employed as cold affusion to check inflammation in injured parts, as in joints, or to keep wounds clean, is of great value.

M. Josse likewise advocated the use of cold water as applied to gunshot or lacerated wounds generally, and in this received the support of the best military and civil surgeons. He declared that—

"When cold water is applied directly after the injury, before reaction has taken place, and when it can be maintained with energy proportionate to the occasion, the phenomena of reaction will be prevented; heat, pain, and swelling will be subdued; and consequently sympathetic fever will not take place; but when the cold has not been applied before the development of the inflammatory symptoms, they will still be conquered by its efficient use."

In these opinions most surgeons will agree, for at the present day the value of cold in checking and controlling inflammatory action is fully recognized; but cold is not now often employed in the manner described, the introduction into general use of ice and ice-bags having led to the adoption of simpler and more effective methods of application. The metallic coil of Leiter, of Vienna,

¹ ["A great deal has been said," says Liston, "about water-dressing, and the merit of introducing it. Water has been applied to sores from time immemorial. The simple element, water, was supposed to be congenial to wounds and sores; it was used to cool parts. The water-dressing has been used in my hospital and private practice for a long series of years, etc." (Practical Surgery, p. 162. Philadelphia, 1838.)]

is probably the best method of applying cold. I have used it freely and like it much. It seems to embody in itself all the advantages, without the disadvantages, of all other known methods of refrigerating a part.

However valuable cold-water compresses or bandages, hot fomentations, or a warm-water dressing, may be for application to parts that have been injured, bruised, or inflamed, they cannot be strongly recommended as dressings to parts in which wounds exist, for it is now a fairly well-recognized fact that water, *per se*, helps better than anything else to encourage in an injured or half-dying tissue, as well as in the secretions of a wounded part, chemical and fermentative changes, by means of which septic poisons are generated, or made to flourish, and from the absorption of which blood-poisoning is known to follow. Water, holding some antiseptic substance or salt in solution, may, however, be used, the antiseptic preventing or neutralizing the septic changes which the water by itself might encourage. In wounds, therefore, that are much complicated with contusion and laceration of parts, and to which hot or cold fomentations seem applicable, these medicated water dressings may be employed; it being left to the fancy of the surgeon, whether he shall use carbolic acid, 1 in 20 of water; boracic acid, 1 in 50; salicylic acid, 1 in 50; thymol, 1 in 1000; iodine tincture, 1 in 80; or permanganate of potassium, 1 in 50. For my own part, I have for years given up using water as a dressing for wounds, whether with or without antiseptic substances, for I have found that oily solutions of the same substances have advantages over the watery preparations which render them far safer and more satisfactory. Oily antiseptic applications are without doubt the best dressings for wounds which we possess, and of these, one composed of terebene one part and olive oil three parts, deserves, as already mentioned, the preference.

DRY DRESSING OF WOUNDS.—A dry dressing to a wound is to be preferred to one of which simple water forms a part, since with it the sanguineous or serous exudations are more or less absorbed and rendered inert, and the surface of the wound is kept quiet and protected, as by a scab, from outside injurious influences; whereas, with a water dressing, the injured surface of the wound and the wound-exudations are encouraged to undergo chemical and fermentative changes, by which the risks of absorption of septic matter or poison are much increased, and the dangers of the simplest wound greatly enhanced. If the dry dressing be composed of some absorbent material, such as the absorbent cotton or lint, and impregnated with an antiseptic substance, such as boracic or salicylic acid, or iodoform, its efficacy will be increased, since the dressing, under these circumstances, may be left untouched for some days, even for a week, and the healing of the part will not, therefore, be interfered with. Repair, as a consequence, will go on with greater rapidity and certainty; the secondary wound dangers will be diminished, and the ultimate issue of the case will be rendered more satisfactory.

When a wound is *small*, and the surgeon has no doubt as to the propriety of seeking to obtain its immediate union, the dry dressing can be recommended, for it, without doubt, helps better than any other to bring about the "quick union" which is sought. When the wound is *large*, or *deep*, the same recommendation cannot be made, and the dry dressings, if used, should only be so after every care has been taken to provide for the free drainage of the part. They should, moreover, only be employed when there is a reasonable hope of the parts healing by primary union. When a wound is *much lacerated* or *contused*, dry dressings are not applicable, since in these no surgeon would entertain the thought of repair being brought about by rapid union, and where this hope cannot reasonably be entertained, the use of the

dry dressings should be discarded. In brief, in all wounds, small or large, when repair by "quick union" may reasonably be looked for, dry dressings are applicable, due provision having been made for efficient drainage. In all lacerated, contused, or deep wounds, in which repair by granulation is to be expected, these dressings are not to be recommended.

EARTH DRESSINGS.—Earth, as a dressing for wounds, has doubtless been used by savage nations from an early period of the world's history, but it was first brought before the notice of surgeons by Dr. Addinell Hewson, of Philadelphia, in 1872; and from his work upon the subject, it seems that he first resorted to this mode of treatment in 1869. Dr. Hewson was first led to employ the earth as a deodorizer, in a bad example of compound fracture of the leg; and, as the results in this case were good in all respects, he began to employ it as a primary dressing to wounds. The earth used by Dr. Hewson was dried, yellow, ferruginous clay, which had been well sifted through a fine flour sieve, and he claims for its use many advantages. He maintains that it is cool and pleasant to the patient as a local application, and that it has a marked influence in soothing pain. In burn cases and in those of carbuncle, this relief is very striking. Dr. Hewson has satisfied himself that earth, besides being a deodorizer, has a marked influence in preventing putrefaction; that in no case does it provoke or aggravate inflammatory action in a wound, but that in many, it retards or arrests it; and, above all, that it promotes the healing process in wounds of every description, as well as in ulcers. The way in which the clay acts as a dressing may not be clear, but it seems reasonable, from the evidence adduced by Dr. Hewson and others, to conclude that it has by its powers of absorbing gases, and more particularly oxygen and ammonia, a chemical action upon the part to which it is applied, and that by virtue of this action it is an efficient means of delaying decay and putrefaction, and of preventing fermentation in animal tissue. Besides this, it excludes air from the wounded tissues, absorbs moisture and excess of discharges, and helps in a measure to give support to wounded parts.

The dressing is applied directly to the wounded or ulcerated surface, by dusting over it the pulverized clay; or, in the case of a stump, by placing it upon a bed of dry clay, in a box extemporized of binder's board, and by completely covering in the whole surface with some more clay. In some cases, when the clay becomes saturated with the discharges, the dressing has to be renewed daily; in others, it may be left for two or more days.

Upon the whole, this mode of practice has not extended far beyond the sphere occupied by its originator, and it does not seem to possess any advantages over the more cleanly and simple processes which are now at the disposal of surgeons. Some years ago, when Dr. Hewson was in London, I was tempted to give the method a trial; but I soon gave it up, as experience was not in its favor. The dirtiness of the dressing was not compensated for by any advantage. This, however, may have been because I was unable to obtain the right kind of ferruginous clay.

ALCOHOLIC DRESSING OF WOUNDS.—Hippocrates, Paracelsus, and others employed wine as a dressing to wounds, and they did so under the idea that it dried the part, and in the belief that a dry condition was nearer a state of health, whilst humidity was nearer that of disease. Their followers used wine in which astringents were dissolved, such as gall-nuts, oak-bark, etc. All did so, moreover, with the view of arresting bleeding. In more recent times, the alcohol dressing has been made popular by Nélaton, who used it largely, and found it of value. It may be applied in the form of simple alcohol, or, which seems preferable, in that of the camphorated spirit of

wine, as originally used by Dionis. The dressing is said to be a coagulant and astringent, and, with such properties, to favor primary adhesion. In open wounds, it is said to act as a healthy stimulant to the granulations, and as a disinfectant, thus helping repair, and guarding against septicæmic changes and other wound complications.

Nélaton employed compresses saturated with alcohol, and he believed the camphorated spirit to be useful only in proportion to the alcohol it contained. M. Chédevergue asserts "that camphorated spirit of wine is without contradiction the best disinfectant that can be found for the treatment of wounds and ulcers," and he makes this statement after a careful investigation into the value of every known antiseptic, not excluding carbolic acid. The spirit is supposed to have the power of dissolving the pus cell, and of obviating its tendency to decompose, and of closing any open vessels. Maisonneuve bathes the raw surface of the wound with the spirit, and, having brought the divided edges together, and having adjusted them with sutures or adhesive plaster, so placed as to allow of the free escape of discharges, envelops the whole in a bandage steeped in tincture of arnica, and at times applies over the whole the apparatus for "pneumatic aspiration," which will be again referred to. The disinfecting and cleansing power of the spirit, applied in this manner, probably helps the draining influence of the aspirator.

Upon the whole, the alcohol dressing may be favorably regarded, whether simple alcohol or spirit of camphor be employed. It has, without doubt, a cleansing, and probably a disinfecting influence on a wounded surface, while, at the same time, it helps materially to arrest capillary bleeding and that serous oozing which is so detrimental to primary union. In its use, however, the surgeon should never be induced to forget the value of the other essential points of practice to which attention has been drawn, and particularly drainage.

PNEUMATIC ASPIRATION AND OCCLUSION.—Maisonneuve's method of "Pneumatic Aspiration," which he employed with some success before 1867, and J. Guérin's plan of effecting "Pneumatic Occlusion," promulgated in 1865, have already been described in the article on Amputations, Vol. I. page 601. It is essential that the aperture of the India-rubber cap, in Maisonneuve's apparatus, should fit the limb accurately, but the crown or lower part may hang some distance from the wound. A few strokes of the piston, morning and evening, suffice to draw the discharges from the stump into the jar, where, in the absence of air, they accumulate without danger of decomposition; while the healing of the wound is facilitated by the accurate and immovable adaptation of its surfaces, and by the exclusion of air. This practice of Maisonneuve's has three main objects in view, all of which are of importance: (1) to check the formation of matter; (2) to prevent its decomposition when formed; and (3) to prevent its poisonous action on the system by entrance into the circulation. It is essentially based upon the principle of drainage, and in that point of view is valuable. In exceptional cases, and particularly in certain cases of amputation, it may be employed, but as a general mode of treating stumps it does not appear to possess such advantages over simpler methods as to make up for the difficulties and expense of its employment.

ANTISEPTIC IRRIGATION OF WOUNDS.¹—The value of the antiseptic irrigation of wounds is not, at the present day, likely to be disputed by any surgeon, and a difference of opinion is only probable as to the antiseptic which shall

¹ [The treatment of wounds by Prof. Lister's "Antiseptic Method" is described in a separate article, page 63.]

be used, the mode of its application, and the character of the wound to which it is applicable. Every surgeon seeks to make and to keep his patients' wounds as clean as possible, and by means of antiseptic solutions or applications to destroy, neutralize, or guard against any and every outside or local influence that can possibly bring about or encourage chemical or fermentative changes in a wound.

It is true that, within the last few years, a school of surgeons has been formed, the members of which talk of "Antiseptic Surgery," and claim for themselves the title of "Antiseptic Surgeons," as if it were applicable to themselves alone, or rather to such of their body as have a belief in the germ theory as a cause of most, if not all, the surgical ills to which wounded flesh is heir; who assert, rather loudly and dogmatically, that "antiseptic surgery" must stand or fall with the theory upon which their practice is based; that no unbeliever in the theory is likely to carry out the practice with any probability of success, since it is only by a staunch believer in the theory that care and attention to every detail of treatment, sufficient to bring about a good result, are likely to be given.

It is true, also, that the results claimed for this practice are great, very great, beyond all previous belief; that, according to these gentlemen, operations which in former times were looked upon as dangerous, can now be undertaken with "certainty" of success; and that others which have hitherto been regarded as unjustifiable, are now legitimate and safe. In fact, the upholders of this theory and adopters of this practice maintain that exploratory and operative measures, which have been regarded as being beyond the province of the surgeon, may now be calmly and quietly undertaken with a "moral certainty" of being followed by a good result. Thus it is that our sanguine *confrères* talk of cutting into healthy joints with the "certainty" that no danger will follow, and declare that great operations upon the bones of the knee may be undertaken with the feeling that in so doing we do not subject the patient "to any risk whatever." That a wedge-shaped piece of bone may be taken from a deformed femur, with the confidence that such a produced compound fracture is "perfectly safe," and "without risk;" and last, but not least, that the peritoneal cavity, under "antiseptic precautions," may be opened "with impunity."

I need hardly say that much of this is bold assertion and nothing more, and that it is apparently due to the sanguine temperament which seems attached to those who pin their faith to a taking theory, and adopt the practice which is based upon it, in blind deference to the authority of its distinguished originator; for facts, calmly looked at, neither by their number nor by their weight, justify these conclusions, but irresistibly suggest that an enormous superstructure has been raised by the ingenuity of its builders upon a narrow foundation, and that good results have been too hastily attributed to causes which have been but some of the factors of a work to which others equally potent for good have without doubt contributed. Facts, indeed, have been employed by our self-styled "antiseptic" friends, as legal advocates use small data which tell in their favor, to support the cause they have in hand; but not as the judge who has to weigh evidence, and with an unbiased mind give judgment. It is only by this explanation that we can understand how the "antiseptic surgeon," when he gets a good result, is so fond of asserting that such could not have been brought about by any other form of practice than that which he has adopted; and, when he is attempting an operation which may in all truth be called experimental, if not rash, maintains that he undertakes it "under the spray" with all confidence, and with a moral certainty of meeting with success.

We must admit, however, that surgery is now much more successful than

it was twenty years ago, and that of the many factors which have brought about this result, the employment of antiseptics stands foremost; and if we are not altogether indebted to Mr. Lister for their use, we are unquestionably indebted to him for the able and persistent manner in which he has both advocated their employment and demonstrated their value. All honor, therefore, to the name of LISTER, for having helped, more than any one else, to establish the value of antiseptic drugs and antiseptic precautions in the practice of surgery, all over the world. Let those who smile at his theory, join with those who believe in it, in giving him this just meed of praise; and let those who do not believe in the efficacy of the spray, do their best to prove to those who do, that all the advantages of the "antiseptic system" can be obtained by simpler means than by its use.

Amongst these means, what must be called the *antiseptic irrigation of wounds*, in my judgment, stands foremost. *Antiseptic irrigation* means the washing of a wound with an antiseptic solution, with the view of destroying any and every germ or element that might possibly set up chemical or fermentative changes in its secretions. It is as applicable to fresh wounds, accidental or operative, as it is to the suppurative or foul, and it is as valuable as a preventive as it is as a curative means. In my own practice, the solution employed is, as has already been mentioned, iodine water—that is, a mixture of the tincture of iodine and water in the proportion of one part to thirty—and, after operations, this should be applied hot. It may be used by means of the irrigating bottle, described at page 26 (Fig. 223), or by means of sponging. When sponges are employed, they should be well soaked in this fluid, and subsequently, before the wound is dressed, should be used to absorb all excess; for this lotion, when applied warm, has more power than any other of which I know, to bring about that desirable "glazing" of a wounded surface which is so valuable as a first step towards quick or rapid repair, and to check capillary bleeding. In suppurating wounds, the same lotion cleanses better than anything else, and has the power of destroying germs of evil, as well as other more vaunted germicides. For the irrigation of a chronic abscess, or sinus, it is equally to be advocated; indeed, as a purifying and antiseptic lotion for all wounds of external parts, as well as for all suppurating cavities, it can be highly recommended. I have employed it for years past, as a purifying agent, but without germicidal intention, with excellent results; and although I have seen much of the spray and carbolic acid practice, I cannot yet see that its results are better than my own. Those who prefer carbolic acid as an antiseptic, can use it in the same way, in the strength of one in thirty or forty; and thymol, boracic acid, chloride of zinc, oil of eucalyptus, or any other known antiseptic, may be similarly employed. The essential parts of the practice consist in the thorough ablution of the wounded or diseased part with the antiseptic solution, after the arrest of all bleeding; the drying of the surface of the wound as far as possible with an antiseptic hot sponge, applied with moderate pressure; and subsequently the careful dressing of the wound with some antiseptic substance, in the way that was described on page 33.

SUBCUTANEOUS WOUNDS.

When John Hunter, in 1794, in describing injuries, divided them into those in which the injured parts did not communicate externally—as strains, bruises, simple fractures of bones, or divisions of tendons; and those which had an external communication—as compound fractures and wounds of all kinds; and laid it down, moreover, as a law, that the injuries of the first class seldom inflamed, whilst those of the second commonly both inflamed and suppurated;

he established a principle of which "indeed it seems hardly possible to exaggerate the importance" (Paget), and laid the foundation of a branch of surgical practice now known as *Subcutaneous Surgery*. Why it is that extensive injuries to soft parts, when covered with skin, should undergo quiet and thorough repair, with little or no constitutional disturbance, may not be clear; but daily experience teaches us that dislocations of large joints, fractures of bones, severe contusions and lacerations of soft parts, associated with copious local hemorrhages, and even crushes of all the subcutaneous tissues of a foot or hand, as a rule, do well, provided that they are not interfered with by meddling practice, but are placed in the most favorable position for natural repair to carry out its silent work. Whereas the same experience tells us, with no uncertain voice, that the presence of a wound, however small, may change matters all round, and turn an injury which, had it been subcutaneous, might have been regarded as trivial, into one of a serious and complicated kind; and this fact is well exemplified in the different course usually taken by a simple and a compound dislocation or fracture. What there is in the air that makes this wide difference, is now, as it ever has been, open to argument; and whether it is the stimulating or chemical influence of the oxygen, the irritating influence of atmospheric germs, the length of time the part is exposed, rather than the mere fact of exposure, or some other cause, may be subject to dispute. In modern times, the germ theory has found much favor, and has been the fashion; and attempts have been made to assign to the presence of germs every evil influence, and to regard these as the cause of inflammation and suppuration in every open wound. But this view can hardly be sustained, for, on the one hand, even in subcutaneous injuries, in which no air can get in, inflammation and suppuration may ensue; while, on the other hand, in even severe examples of fractured ribs, complicated with emphysema over the chest, body, head, and extremities—in cases in which the whole cellular tissue of the body seems infiltrated with unfiltered air under most unfavorable circumstances—it is quite exceptional for any inflammation of the infiltrated parts to take place; indeed, I may say that I have never seen an instance in which it occurred. As corroborative evidence, I may refer to some observations made in 1857, by Malgaigne, who, to test this question, made animals emphysematous with common unfiltered air, and then fractured their bones, divided their tendons, and opened their joints, *subcutaneously*; though the parts operated upon were surrounded with air, no inflammation followed.

For my own part, I am disposed to think that it is not the mere exposure of a wounded part to the influence of air, that does the harm, but its prolonged exposure; since it is certain that where wounds are sealed rapidly, after the receipt of an injury, and are thus placed much in the position of subcutaneous injuries, repair goes on silently and well. Even bad compound fractures, when sealed early from the influence of air, heal, as a rule, like subcutaneous injuries.

REPAIR OF SUBCUTANEOUS WOUNDS.—It may be accepted as a truth, that subcutaneous wounds are repaired much in the same way as open wounds that heal by quick or primary union; that is, when the wounded parts are brought or kept in contact, they simply reunite; and this applies to hard as to soft tissues. The process of repair in both cases is a quick physiological one, not unlike that of development and growth. The action that attends the process is just enough to bring about the required result, but no more; when it is excessive, inflammation is said to exist, and this inflammation, in subcutaneous as in open wounds, always prevents, checks, arrests, or undoes the work of repair. In truth, the less there is of inflammation in a wounded part, subcutaneous or open, the more

perfect and steady is the reparative process. Surgeons are well aware that when inflammation occurs in a part which has been the seat of some subcutaneous operation, the process of repair is likely to be interfered with, if not arrested; for, as Paget observes, the more manifest are the signs of inflammation, the less is the quantity of the proper reparative material, and the slower in the end is the process of repair.

When tendons are subcutaneously divided and drawn asunder, their repair takes place as follows:¹—

When such a tendon as the tendo Achillis is divided subcutaneously, the divided ends separate, in an infant for half an inch, and in an adult for from one to two inches, the degree depending much upon the healthy condition of the divided muscle, and the amount of movement subsequently permitted in the ankle-joint. The reparative process begins with increased vascularity in the sheath of the tendon, which is followed by the infiltration of a blastematous material into the meshes or spaces between its fibrous elements, exhibiting the development of innumerable small nuclei, a few cells of large size and irregular form, with granular contents, or, perhaps, with one or more nuclei, and studded with minute molecules of oil; a blastematous material, in which the cell forms do not develop beyond the stage of nuclei, appears to be the proper reparative material from which new tendon is developed. This nucleated blastema soon becomes vascular, capillary vessels having been seen in it on the eighteenth day; the nuclei assume an elongated, spindle, or oat-shaped form, and are seen after the addition of acetic acid to be arranged in parallel linear series. The tissue becomes gradually more fibrillated, and at last fibrous—a solid bond of union subsequently forming between the divided extremities of the tendon, which is tough to the touch, but to the eye presents, for at least three years, a grayish, translucent appearance, distinguishing it at once from the glistening old tendon. This new tissue remains during life as permanent, and has little tendency to contract subsequently. Adams's observations rather lead him to the conclusion, that the required portion of new tendon may be obtained during a lengthened period of formation, that is, about two or three weeks, under the ordinary conditions of health; but that in paralytic cases, or with patients of feeble health, this period may be doubled.

Adams informs us, also, that the divided extremities of the old tendon take no active part in the reparative process during its earlier stages, although the cut ends subsequently become rounded, and their structure softened. They become enlarged and exhibit a tendency to split, and thin streaks of new material, similar to that already described, are seen between the fibres; the ends are joined by these means. At a later period, the bulbous enlargement gradually diminishes. When a tendon is divided a second time, there is but little separation of its ends, and this is probably due to adhesion of the new tendon to the neighboring fibro-cellular tissue, in which fact is found an explanation of the unsatisfactory results of second operations. There is no reason for believing that, in the treatment of deformities by tenotomy, direct approximation and re-union of the divided extremities of the tendon must first be obtained, and that the required elongation is afterwards procured by gradual mechanical extension of the new connecting medium, as we would stretch a piece of India-rubber. When much blood is effused between the divided ends of the tendon, it has to be absorbed; it acts merely as a foreign body in the part, and retards repair.

TREATMENT OF SUBCUTANEOUS WOUNDS.—When rightly treated, these wounds are generally repaired readily, and, as Hunter asserted, without inflammation; but when not rightly treated, “the subcutaneous nature of a wound is not of itself a sufficient protection against inflammatory complications,” “and a clumsily performed subcutaneous operation may be as dangerous as an open wound; sometimes even more so” (Adams). In the treatment of these, as of

¹ British surgeons are chiefly indebted, for their knowledge of the process of repair in subcutaneous wounds, to the investigations of Sir James Paget and Mr. W. Adams, and the description in the text is mainly taken from the latter author's work on the *Reparative Process in Human Tendons*, etc. (London, 1860.)

open wounds, there are, consequently, essential points of practice to be observed, in order that good results may be obtained; and these are not unlike those which have been laid down for the treatment of open wounds. That is to say, the injured parts are to be placed as far as possible in a position of ease, and in one in which the contact of the divided tissues is assured, when contact is called for. The parts are, moreover, to be fixed by splints, bandages, or other dressings, in a condition of absolute immobility. The seat of injury is to be protected from all outside injurious influences, and to be supported by moderate pressure; and, what is more, is to be undisturbed, in order that neither by manipulation nor movement shall repair be retarded; for a subcutaneous wound is as susceptible to injury from mechanical interference as is an open wound.

In treating the wounds made by the operations of subcutaneous surgery, the same principles of practice are applicable, and they are well summed up by Adams as follows:—

“There are certain conditions which must coexist to render the subcutaneous operations exempt from inflammation. These conditions are: 1st. That the knife used must be of small size. 2d. That the operation must be performed quickly and neatly, with decision rather than force, and with as little disturbance to the soft parts as possible. 3d. That the wound must be immediately closed, and a compress and bandage applied, so as to prevent effusion, and to support the part. 4th. That perfect quiescence to the part be insured for three or four days, and the dressing remain undisturbed. When all these conditions are strictly observed, it matters little whether large muscles, or tendons, or ligaments are divided; or even whether the large joints of the body are opened.”

From all this, it is to be gathered that in the treatment of subcutaneous wounds, whether of accidental or operative origin, there are four essential requisites to be provided for, viz., Position, Immobility, Pressure to support the parts, and Time for repair to perfect itself.

COMPLICATIONS OF WOUNDS.

On the well-founded assumption that a wound, when made into healthy tissues in a healthy subject, will heal by natural processes if placed in the most favorable position for repair, and not interfered with, it cannot well be disputed, when a wound does not heal thus kindly, that there must be some obstacle or hindrance to its natural progress; and this will doubtless be found either in the nature of the wound itself, or the mode in which it has been treated, or in the peculiarities of the subject of the wound, or the surroundings of the case.

When the hindrance is due to *the wound itself*, or to its *treatment*, it may be that some foreign body has been left to irritate; that the hemorrhage which ensued primarily on its receipt has not been effectually arrested, and that a clot has formed between the edges of the wound; that a “recurring” bleeding has taken place within a day or so after the infliction of the wound and its first dressing, from some imperfection in the treatment of the bleeding vessels, or from excessive reaction; or that a collection of serum has been allowed to form in the depths of the injured tissues. In most of these cases, the causes of non-repair are clearly referable to a want of care or skill on the part of the surgeon who has had the early treatment of the case, and must be set down as preventable causes. By the same want of care, the edges of the wound may not have been properly adjusted or kept in apposition; the injured limb may not have been made immobile; and, as a result, spasmodic muscular movements and jumpings of the limb may have been excited;

no provision, or an insufficient provision may have been provided for drainage, and, as a consequence, the wound may have been irritated by retained secretions, and possibly made to inflame by the tension which the retained secretions have produced. Harm may also have been brought about by the want of due attention to the dressing of the wound, and to its efficient protection from outside injurious influences. Other causes of non-repair may be the unsuitable character of the applications with which the wound is dressed, of the position in which it has been placed, etc.

When the obstacle to natural repair exists in *the subject of the wound, or in the surroundings of the case*, it may be that it will be found in the age, temperament, or feebleness of the patient—as expressed by deficiency in the healing act, excess of pain, or inflammation of the wounded parts; in the unhealthy atmospheric condition of the chamber or residence in which the patient rests, as shown by unhealthy action in the wound, erysipelas, or septicæmia; in the unsuitable character of the patient's food; in want of proper nursing, etc. Under any circumstances, the obstacle to repair will be found in one or more of these causes, and it is for the watchful eye of the surgeon to discover the particular defect, in order that he may apply the proper remedy. It is well, however, for the student to recognize the fact that most of these causes are preventable, and that they are as a rule due to some want of care in the primary dressing of the wound; let it be repeated, therefore, that in all cases, and under all circumstances, too much care cannot be bestowed upon the management of fresh or recent wounds, to carry out the essential points of treatment to which attention has been so often drawn.

CONSECUTIVE HEMORRHAGE OR RECURRENT BLEEDING.—This form of bleeding is that which takes place within twenty-four or forty-eight hours after the reception of the wound. When it occurs, it is of little consequence whether it is to be attributed to some imperfection of the means employed to check the primary hemorrhage, or to the re-opening, during the period of reaction, of a vessel which had been temporarily sealed by a clot at an earlier period of the case. It has to be dealt with, and with decision. When trifling in amount, it need not be regarded with anxiety, and more particularly when there is room for the blood to escape through the drainage opening or tube, although even then it will be well for the surgeon to see that the wounded part is elevated and watched. If the bleeding vessel be a small or cutaneous one, these means will probably be enough. If, however, the bleeding is persistent, or if the parts about the wound swell, and become tense and painful, and more particularly if pallor of the skin, feebleness of pulse, restlessness, and other signs of collapse furnish definite signs and symptoms of loss of blood, the wound must be re-opened, the clots turned out, the source of the bleeding looked for, and the vessel secured. At times the mere opening and exposure of the wound will arrest bleeding, and, under these circumstances, when the bleeding vessel cannot be found, it is well to leave the parts exposed for a few hours, and either to bring them together again when they have glazed, and when most chances of bleeding have passed, or to leave them open to granulate. The wound should, however, be left open under only exceptional circumstances: when the hope of quick union is very small, or when such union is undesirable.

When the bleeding vessel has been found, it is to be secured, and the wound treated as a fresh one, and reclosed. At times, where oozing of blood is persistent, moderate pressure upon a wound does much good; and this may be well applied by means of an ordinary, or a rubber bandage over a sponge or elastic antiseptic pad. Care must be taken, however, that the pressure be not too great.

SECONDARY HÆMORRHAGE.—This is the form of bleeding which occurs after the lapse of two or three days. It may occasionally be due to the existence of the hemorrhagic diathesis; but is more commonly owing to some ulceration of the vessel in the line of ligation, before the vessel itself has been closed by natural processes; to some sloughing of the end of the divided artery or vein, with or without sloughing of the wound itself; to some imperfection in the means employed for the arrest of the primary bleeding; or to the accidental separation of a ligature.

When it takes place in a wound that appears to be healthy, and in which the reparative process seems to have progressed in a satisfactory manner, the hemorrhage will probably be found to have come from a vessel that has been imperfectly secured, or the end of which has been irreparably injured; and under these circumstances, if the bleeding be profuse, and evidently from a large artery, the wound must be re-opened, and the bleeding orifice sought for and dealt with as in the original wound. But if, on the other hand, the bleeding is not severe, and the probabilities of the case suggest that the vessel is not large, the injured limb should be raised, and moderate pressure applied; for by such means there will be a good prospect of a successful issue being obtained. Should a recurrence of the bleeding, however, occur, and the effects of loss of blood show themselves, the wound must be re-opened, and the bleeding vessel secured. When the bleeding comes from a vessel which has sloughed with the surrounding tissues, it is better practice to secure the vessel at a distance from the wound. When, however, the bleeding takes place in a case in which an artery has been tied in its continuity, the surgeon should delay re-opening the wound unless the evidence be strong that the blood comes from the supplying or afferent trunk; since experience has fairly taught us that, in a large number of these cases, the blood comes from the lower or distal orifice of the ligatured vessel, and that, under such circumstances, it may be readily arrested by the elevation of the limb and well applied pressure. In all cases, however, when the bleeding is recurrent and persistent, the wounded vessel should be looked for, and secured either at the seat of bleeding, or, when this is either difficult or dangerous, at a higher point.

PAIN.—There is no effect of a wound or operation which varies more in degree than pain. In one case the subject of a simple wound will suffer much pain, while another individual with a severe wound will experience but little. Persons vary greatly in regard to nervous susceptibility; nevertheless pain is under all circumstances a serious symptom, and a great evil; for it tends to depress the moral and physical forces of the strongest patient, and to exhaust even to death the feeble powers of the fragile. I am convinced that I have known pain to kill.

In all wounds, therefore, operative or otherwise, it is important that pain should be guarded against, and for this object surgeons can do much by care and forethought. The wounded parts should be well protected, and so placed as to give rise to the least inconvenience or distress; the dressings, likewise, should be so regulated as to give comfort. In most wounds, and after most operations, some pain will be necessarily experienced, but, as a general rule, it will subside in the course of one or two hours. To relieve this symptom, however, it is well to give opium in some of its forms, and for this purpose, after an operation in which an anæsthetic has been used, it is an excellent plan to introduce into the rectum, before the patient becomes conscious, a suppository containing from a third to half a grain of morphia. The anodyne begins to exercise its calming influence before the effects of the anæsthetic have quite passed off, and in some instances the action of the two

drugs appears to be continuous. In other cases the subcutaneous injection of a *small* dose of morphia may be resorted to, or a full dose of the same drug may be given by the mouth. Under all circumstances, the early pain after a wound or operation is to be subdued.

When the pain is persistent and continuous, after the healing process has progressed, or perfected itself, some nerve complication may be suspected: it may be that some nerve branch has been included in the ligature placed around a vessel; or some nerve trunk may be so involved in the cicatrix of the wound, or so bound to bone or fascia, as to be kept continually irritated, or even inflamed; or it may be that no definite cause for the pain can be made out—when the case, for want of better knowledge, is regarded as neuralgic. When the cause of the pain can be determined, this should be removed, and when no cause can be ascertained, the surgeon may be justified in cutting down on the affected nerve, and stretching it; or in subcutaneously dividing it, as suggested by Hancock. As constitutional remedies, narcotics may be given, with tonics such as quinine, iron, and arsenic.

MUSCULAR SPASMS.—The muscular spasms or twitchings which follow wounds, and more particularly amputations, can generally be prevented by the careful application of splints and well-directed pressure; they should be put down as preventible sources of distress, and should be guarded against in the early dressing of the case. Well adjusted pressure, with rest of the injured part, is the one thing to be relied upon to prevent and relieve this symptom, and it rarely fails. The judicious use of narcotics should at the same time not be neglected.

DEFECTS IN THE HEALING PROCESS, AND DISEASES OF GRANULATIONS.

Defects in the healing process may show themselves in either deficiency or excess of action, or in some morbid state of the granulating wound.

DEFICIENCY OF ACTION.—In the old, and in the very feeble, whether from disease or otherwise, deficiency in the reparative power is to be expected; since, for repair, a balance of reserved force at the bank of health is requisite, and, where such a balance is absent, the extra force required for healing will be deficient. Wounds in subjects such as these, consequently, simply fail to heal, or heal slowly, or in the worst way—the failure resulting from a want of either the right quantity, or the right kind of nutritive supply and nerve force. In wounds in which quick union is aimed at, the parts which have been brought together will simply not unite; and they will remain together only as long as they are held in position by the mechanical means employed for the purpose. In the young and in the middle aged, the same failure in repair is likewise at times seen in cases of harelip or other plastic operations in which quick union is needed for success; the parts do not unite by primary adhesion, but gape, and granulate, and the operations consequently fail. In such patients, also, fractures sometimes fail to unite as they ought, or unite but slowly, and this may be the case even when no definite cause for the deficiency in the reparative process can be detected. In all such instances, however, there is want of power from some general or local cause, which must be detected before treatment can be rationally or successfully applied.

In wounds in which union by primary adhesion is looked for, the failure may be partial or complete. When it is *complete*, the wound must be regarded and treated as an open one, and under these circumstances the sutures should

be removed, and the surface cleansed and kept clean, and then stimulated by some stimulating dressing such as carbolized oil 1-40; terebene and oil 1-4; boracic acid lotion 1-10; boracic acid ointment 1-5; or chloral or chlorate of potassium lotion, ten grains to the ounce. At the same time, the wounded part should be placed in the most comfortable position, and in that which will be most favorable for the process of repair. The constitutional treatment should likewise be of a tonic and stimulating character, with good, abundant, though simple, food, and with wine or spirits in sufficient quantity to aid its digestion, and to enable the feeble heart to send its contents to the nerve centres, so as to give them force, and to the digestive apparatus, so as to enable it to utilize the food and get rid of effete matter. The patient at the same time should be placed in the best hygienic surroundings.

When, however, the failure in primary adhesion is not complete, but *partial*, and when there is the smallest foundation for the hope that by keeping the parts together the required repair may yet be secured, the sutures should be left in position, the wound cleansed with some medicated antiseptic lotion, and, if necessary, either another suture introduced, or some other means employed to bring and to keep the parts well together; even should failure follow the attempt to gain primary adhesion, success may follow another effort made to secure secondary adhesion of the granulating surfaces, or union by the *third intention*. Where the cause of non-union is local and only temporary, these measures will often succeed, and will turn what seemed to be a failure into a satisfactory result. In harelip and in most plastic operations, a rigid adherence to this surgery of hope and discretion is to be highly commended.

DEFECTS OF THE HEALING PROCESS FROM EXCESS OF ACTION, OR INFLAMMATION.

—When excess of action takes place in a wound in which repair by primary adhesion is looked for, disappointment, in all probability, will be the result; for whenever there is in a wounded part more vascular action than is required for the reparative process to perfect its work, repair is first interfered with, then stopped, and, finally, what might have been repair becomes dis-repair, and the wound, when not held together mechanically by sutures, strapping, or bandages, gapes or opens. When excess of action, or inflammation, attacks an open wound that is granulating and cicatrizing, repair likewise ceases, and becomes dis-repair; the granulations, instead of presenting a healthy, florid appearance, and secreting a bland, creamy pus, become œdematous or glazed; what has been a granulating surface becomes an ulcerating one; and the secretion from the wound changes from pus, to a thin, serous discharge, with more or less *débris* of tissue. The thin, red, marginal line, with its cicatrizing edge extending on to the granulating surface, presents a more or less extended area of vascular congestion; this being, when the action is sthenic, red to an extreme degree, but when asthenic, tending towards blue, the redness shading off in intensity towards the blue lividity of congestion. The surrounding parts, moreover, will, under these circumstances, be tense from inflammatory effusion, hot, and painful, when the inflammation is acute; but when this is of a lower type, they will be œdematous, boggy, less painful because less tense, and less hot. When the local inflammation is sthenic, the constitutional disturbance will coincide with it in type, and the symptoms will be those of inflammatory fever; when the local action is of a low and asthenic form, the constitutional symptoms will partake of the same nature, and will approach those of low fever.

It is to be known also, and remembered, that the acute or *sthenic* form of inflammation, as a rule, attacks a wound when newly made, and is generally excited by some local cause; possibly from the original injury, more probably from some imperfection in the primary dressing, and most probably

from the retention of some irritating fluid in the depths of the wound, from want of proper drainage. This is more likely to occur in wounds of certain parts or tissues—as in wounds of joints, wounds of large cavities, and deep, punctured wounds—than in lesions of another character.

The *asthenic* form of inflammation, as a rule, attacks wounds at a more advanced period; when the first effort at natural repair has been made, and has more or less succeeded, and when it might seem as if the effort to repair the part, and the power to effect that repair, were not commensurate. At any rate, in the treatment of these two forms of inflammation, when attacking wounds, it will be safe to assume that such is the fact; for while in the acute or sthenic variety, a local cause for its production should be looked for, in order that it may be remedied—in the asthenic, or later kind, the recognition of the fact that the inflammation is due to a deficiency of general power, is all important.

Treatment of Inflammation Affecting Wounds.—In the sthenic form of inflammation, the local and general action is to be subdued by giving free vent to pent-up fluids; by the local employment of ice, or of some other means of applying cold; by the local abstraction of blood; and by free purgation. For the latter purpose, there is nothing better, after a good purge, than repeated small doses of a saline cathartic, such as Epsom salts. When suppuration takes place, it must be actively dealt with.

In the asthenic form, general tonics, with stimulants and nutritious food, are essential; and locally, absolute cleanliness, the free exposure of the wound for purpose of drainage, with, possibly, warm medicated irrigation, and the constant use of such stimulating antiseptic applications as the nature of the case may suggest. Cold, locally applied, is rarely beneficial.

DISEASES OF GRANULATIONS.—When an open wound heals, or a cavity fills up with reparative material, it does so by a process of granulation; and when this process takes place in a healthy subject, and under favorable conditions, the granulations present certain appearances, and are known as healthy granulations. When, however, the same kind of repair is being effected in a feeble or diseased subject, or under circumstances which are not favorable for its progress, the granulations present different appearances, these being, as it were, *pathological*, in contradistinction to those which are seen when the ordinary *physiological* process of repair is being carried out; a process which is very closely allied to, if not identical with, that of development and growth.

In a *healthy* granulating surface, the granulations appear as small, conical masses of granulation tissue, covered with a thin layer of pus cells. The granulations are of a bright, florid red color, and are fringed at their skin border with the well-known, thin, blue line which is so indicative of healthy “skinning” or cicatrization; and during the whole of the healing process, this appearance is maintained, the only visible change being the gradual diminution of the granulating surface by the steady approach of the thin, blue line towards the centre. Some wounds undergo contraction at the rate of from one to one and a half inches a week. The skin around a healthy granulating surface will be healthy.

In these granulations, and in their different appearances under diverse circumstances, the educated eye of the surgeon can rapidly read, not only every important change in the bodily condition of the patient, but almost every variation, from day to day, in the patient’s condition, for a granulating surface is, as I have been in the habit of describing it, a kind of weather glass or barometer of health; the surgeon cannot only read in it, as long as it maintains its healthy aspect, that the man who bears it is healthy, and that his different systems—nervous, secretory, and excretory—are doing their duty in a normal

way; but he will be able to recognize in the changed appearance of the granulations themselves, and of the thin blue line of cicatrization, the slightest deviation from the healthy type; for while it is true that, as long as a granulating surface is healing kindly, the inference is correct that the subject of the "sore" is healthy; it is equally certain, when the granulating surface has deviated from the healthy path, that there is something wrong, either in the patient, in the part itself, or in its treatment.

Thus, in a patient who is anæmic, the granulations will be pale and bloodless; and when this condition has been of long standing, they will lose their small conical form, and appear as coarse, watery elevations. When there is any interference with the return of the venous blood from the granulating part, from either heart disease, the dependent position of the limb, or the improper use or bad application of bandages or other mechanical appliances, the granulations will appear *congested* to variable degrees, and may even bleed; they may be so congested and full of venous blood as to put on the purple appearance which suggested to the old authors the name of the "juniper-ulcer," the granulations being so full of venous blood as to appear as blue or black as a juniper; the sore is then, clinically, said to be *congested*. When it bleeds it is generally called *hemorrhagic*.

When from some constitutional or local cause the reparative process is acting feebly, the deficiency of action may be seen in the granulations, or rather in the sore—for under these circumstances the surface of the sore will either present a few ill-formed and feeble granulating spots, or it will appear smooth and apparently deficient in granulations altogether, and will look to the eye not unlike the tense mucous surface of the pharynx. In other cases, the reparative force may be too feeble to express itself in any granulating process, and the sore may present a greenish, dirty-colored surface, discharging an acrid or putrid substance which is clearly blood and serum mixed with the decomposing elements of dead tissue, the ill-formed granulations or granulation-tissue dying superficially, as soon as formed, for want of power to live and develop. In more extreme cases of deficiency of power, what may have been a reparative process not only ceases to be so, but becomes retrograde; what had been a *constructive*, changes into a *destructive* force, and the tissues that should have been repaired break down and undergo molecular disintegration, the sore, instead of healing, becoming an ulcer, and the new tissue dying from want of vitality. At times, when the reparative power is feeble, and yet granulations form, these will present a corresponding appearance; that is, they will have a pale, watery, œdematous character, and the discharge from them will not be normal pus, but a sero-purulent fluid; the granulations that form are of a weak type, and the sore then constitutes a *weak* ulcer.

On the other hand, excess of action may at times affect a granulating or healing sore, and, when it does so, it affects the granulating process as much as it has been shown to do a wound in which quick union or primary adhesion is sought for. In the stage of irritation, or that in which the granulation-tissue is simply over-stimulated, over-action shows itself in an excess of secretion from the granulating surface, in the shape of pus, and probably in some increase in the size and redness of the granulations themselves; and when this is other than a passing condition from some temporary cause, it will soon pass into one of inflammation.

When inflammation attacks a granulating sore, changes will occur similar to those which have been described as taking place when it affects a healing wound.

Physiologically, there will be an arrest of the healing process, an arrest of secretion from the granulations, and, if the action, be lasting, a change from.

what had been a healing process to one of ulceration. The ulceration will be more or less rapid, and associated with all the local and general phenomena of inflammation, such as redness and heat of the margins of the sore and the adjoining tissues, with pain and swelling. The degree and character of the inflammation regulate these appearances; an inflamed sore or granulating surface presents as many different aspects as there are degrees or kinds of inflammation, for inflammation must be regarded as an accidental complication of the sore, and it may attack it at any stage of its progress, or in any condition. At times, the granulating force may be in excess, and so act as to prevent repair. The granulations sprout above and beyond the margins in which the "cutifying" action is carried out, and appear either as elevated, luxuriant granulations in the centre of a sore or at the orifice of a sinus, or as overhanging, florid granulations at the cicatrizing border. In these cases, there is simply an excess of granulating force, and this excess exhibits itself in fungous granulations.

Again, a granulating wound, when of long standing, may show on its surface, or in its surroundings, evidence of the existence of any constitutional or specific condition. That is to say, a chronic sore, in a patient who has a syphilitic taint, may present features by which the presence of the syphilitic poison can be recognized; and a chronic sore, in a scrofulous subject, will manifest conditions which, if not special, as in the syphilitic, will be clear enough to indicate sufficient feebleness and torpidity of action to suggest the existence of some general dyscrasia.

THE ANTISEPTIC METHOD OF TREATING WOUNDS.

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ORIGIN OF THE ANTISEPTIC METHOD.

THE title of "THE ANTISEPTIC METHOD" was given by Mr. Lister to a form of wound treatment founded on certain definite principles, and commenced by him in 1865. For several years previously he had been impressed with the great evils which resulted from the putrefaction of discharges in wounds, and though he had succeeded in many ways in lessening the occurrence of putrefaction, yet it was not till after he had examined the results of Pasteur's researches on spontaneous generation, and on the causes of fermentations, that he was able to systematize his work. Up to this time, scientific opinion, more especially in England, had been divided between two views with regard to the occurrence of fermentation, the one asserting that this process was due to the action of the gases of the air, and particularly of the oxygen, on the discharges, and the other asserting that fermentation was a spontaneous alteration, occurring in organic fluids after their exit from the tissues and vessels, and that it was a necessary consequence of loss of vitality.

As long as these views were current, there was not much hope of entirely eradicating putrefaction in wounds, and its consequent evils. The effort to exclude the gases of the air had been made by several surgeons, and had entirely failed to do any good. Most prominent among the surgeons who had used the so-called "occlusion" method, with the view of arresting the putrefaction of the discharges of wounds by preventing the entrance of atmospheric gases, was Jules Guérin, of Paris. Starting with the good results which followed subcutaneous operations, he attributed these to the avoidance of putrefaction in the wound, or at least to the exclusion of the atmospheric gases from it. He therefore carried on an elaborate series of experiments with the view of excluding the gases of the air from wounds, but without any good result. He sealed up wounds with various materials, especially with gold-beater's skin, but the result was more frequently tension and inflammation in the wound, than the absence of fermentation and a subcutaneous healing. In later years, he tried other means, and at length introduced a special apparatus by means of which the air was pumped away from the vicinity of the wound. Nevertheless putrefaction and its consequences still occurred. Various other attempts have been made on the same principle, and these have in like manner failed. Thus the wound has been covered with collodion, so-called styptic colloid, etc. Leconte and Demarquay substituted other gases, more especially carbonic acid gas, for air, but their method was quite impracticable on a large scale, while it did not prevent fermentation.

While these attempts to prevent putrefaction by excluding the gases of the air were being made, indeed before they had been thought of, it had been found that the addition of various substances to organic fluids, whether outside the body or in wounds, had a marked effect in retarding or preventing fermentation, and notably in preventing smell. These substances therefore received the name of "antiseptics"—substances which prevented putrefaction, or, literally, which acted against the causes of putrefaction. These had been in use for a very long time, chiefly in the form of various balsams, ointments, or lotions. The most efficacious balsams contained various essential oils, which we now know to be powerful antiseptics, while the best lotions had, among other substances, alcohol as their chief component. The treatment of wounds with antiseptics had, however, been carried on in a very desultory manner, and without any fixed guiding principle, till the publication, in 1859, of a paper by Corne and Demeaux on a paste containing coal tar. By means of this paper, the attention of French surgeons was at once attracted to the whole question of the use of antiseptics in the treatment of wounds, and for a year or two very fertile results were obtained. Lemaire more especially took the matter up, and after experimenting with an emulsion of coal tar, with very good results, he at length found that carbolic acid was the chief antiseptic constituent in coal tar, and accordingly introduced it into surgical practice. During the same time, various other antiseptics were brought forward, of which alcohol, in the practice of M. Nélaton, yielded the most important results. As the result of Lemaire's writings, the use of carbolic acid spread very rapidly on the continent, and even in Great Britain a few surgeons (Spence, Wood, etc.) employed it somewhat extensively. Carbolic acid, as used in this way, has, however, many disadvantages, and hence many who had at first employed it largely, gave it up almost entirely, and it seemed likely to fall into disuse, until it was again brought into notice by the writings of Prof. Lister.

All these attempts, however, with the exception to some extent of Lemaire's, were merely empirical, or at least founded on no definite theory of the causes of fermentation. Consequently, the modes in which the antiseptics were used were very various, and as a rule very inefficient. What, perhaps, more than anything else, tended to confuse the minds of surgeons on this subject, was the success of what was apparently a very different method of treatment, and one opposed to any of the existing conceptions of the origin of fermentations. So contrary was it to the views of the majority of surgeons at that time, that great doubts arose in the minds of some whether, after all, putrefaction in wounds could be the evil which it had seemed to be. I refer, of course, to the open method of treating wounds.

THE GERM THEORY.

In the mean time, however, science was making rapid advances in this department, more especially by the labors of Schwann, Schroeder and Dusch, and Pasteur. The theory that fermentation was due to the gases of the air had become untenable. Organic fluids which had been sterilized by boiling, could be preserved for an indefinite time in the presence of air which had been previously heated (Schwann), which had been passed through sulphuric acid (Schulze), which had been passed through water (Pouchet), which had been filtered through cotton-wool (Schroeder and Dusch), or which had simply been allowed to remain at rest for a sufficient time to permit the solid particles suspended in it to settle (Pasteur). It was also shown that no gas, *per se*, had any power of causing fermentation. Pure oxygen, nascent

oxygen, ozone, exhalations from putrefying materials, could be brought in contact with organic fluids and substances without setting up any fermentative changes in them. The cause of fermentation was certainly not the gases of the air, and, in the case of boiled organic fluids and tissues, it was something particulate; something floating in the air, but removable from it mechanically, by filtration, etc.; and destructible by various chemical agencies, such as sulphuric acid, heat, etc. It was thus evident that all attempts at excluding merely the gases of the air from wounds, could not but be abortive, for the gases were not the causes of the putrefaction in the discharges in wounds, and were not even an essential condition of that change; and that their exclusion, therefore, even if thoroughly effected, did not imply the exclusion of the causes of fermentation, or indeed its arrest in any way. The clinical experience of Guérin and others absolutely confirmed this conclusion.

While it was thus established that the fermentation of boiled organic fluids and substances was due to the entrance of dust from the outer world, and not to the action of the gases of the air, or to any change inherent in the fluids or substances themselves, facts were being gradually accumulated which tended to show that unboiled organic materials, among which of course we reckon the discharges from wounds, obeyed the same law; and at the present time this view has been firmly established.

One or two very simple facts will suffice to illustrate this point. Take Mr. Lister's experiment with unboiled urine. The orifice of a flask is covered with a cap of cotton-wool, and the whole is placed in a suitable chamber, which is raised to a temperature of 300° F., and kept at that temperature for a sufficient length of time to destroy any living material in its interior (two to three hours). This heat acts on the air and the dust in the interior of the flask, in the same way that the air is acted on when passed through an iron tube heated to redness, as in Schwann's experiment; the dust is rendered incapable of setting up fermentation. By means of the cotton-wool cap, the air which enters the flask during cooling is filtered of its dust, just as in Schroeder and Dusch's experiments. The glans penis is then washed with 1-40 carbolic acid lotion, which acts in the same way on any causes of fermentation which may be present there. The cotton-wool cap being now rapidly removed, the glans penis is at once placed over the orifice of the flask, and urine is passed into the flask. As soon as the glans is removed, the cotton-wool cap is reapplied, and the flask containing unboiled urine in contact with filtered air is set aside in a warm place. This urine remains pure for an indefinite time, though, if dust be introduced into it, fermentation takes place rapidly. Here we have exactly the same law at work as in the case of boiled organic fluids; the gases of the air cannot cause fermentation; fermentation is not a spontaneous change in the material experimented on; it only occurs when solid particles, removable by heat, filtration, etc., are admitted. I have been able to make out similar facts with regard to tissues removed from the bodies of healthy animals, facts which are further of importance in proving that the particles which cause putrefaction are not normally present in the healthy living body. Take a vessel, cover its orifice with cotton-wool and heat it as before described; then introduce into it some sterilized organic infusion, taking sufficient precautions to prevent the entrance of septic dust; lastly, with various precautions¹ to render any air-dust innocuous, remove portions of the organs from the body of a healthy animal which has been just killed, and introduce them into one of these prepared vessels. The result is, if the experiment has been properly conducted, that many of the tissues of the body may be preserved unaltered for a long time, showing that there are no causes of fermentation present in them, and that they have no inherent tendency to undergo such a change.

As soon as it was clear that fermentation was due to the access to the fermentescible substances of particles from the outer world, and that these

¹ For further details, see a paper "On the relation of micro-organisms to antiseptic dressings," in the Transactions of the Pathological Society of London, for 1879.

particles were destructible by heat and chemical agencies, a possibility of preventing fermentations in the discharges of wounds was opened up, and it was this idea which Professor Lister seized on, and the development of which has led to such fruitful results. A vast number of observations and experiments had shown that there was a very intimate relationship between fermentations in wounds and the constitutional disturbances so apt to follow them, a relation to some extent of cause and effect, and it was quite clear that if the occurrence of these changes could be prevented, a vast advance would be made towards the abolition of the so-called septic diseases. Mr. Lister's aim has all along been to destroy the fermenting power of these particles before they reach the wound, and thus at once place the patient out of danger from any of the consequences which are supposed to be connected with a putrid or fermenting state of the discharges.

PRINCIPLES OF THE ANTISEPTIC METHOD.

While for the practice of the Listerian method it is only necessary to know that the causes of fermentation are *particles*, which reach the fermentescible substance from the outer world, and that these particles are destructible by various chemical means, yet it is of importance to ascertain more definitely what is the nature of these particles, and this knowledge will be found to open up a wider meaning of the term antiseptic surgery than is generally understood. It has been known for several years that in all fermenting fluids low forms of vegetable life are present, forms which are included in a class termed *Schizomyces*, or more popularly known as *Bacteria*. It has also been amply demonstrated that these micro-organisms do not arise *de novo* in these materials, but that they are always derived from a parent. It has further been shown that they enter fluids and tissues from the outer world, being present as particles in suspension, in air, water, etc., or being deposited as dust on surrounding objects. It is also evident that as these bodies are living, they must acquire materials for their growth from the substances in which they grow; they must breathe, take in food to build up and renew their protoplasm, and excrete waste products. It thus follows that the material which serves them for food must undergo a change as the result of their growth; and, since the result of the growth of individual cells in the complex animal organism is the formation from the blood of certain definite substances, there is nothing unreasonable in supposing that the result of the growth of cells floating free in a fluid, will be the formation of certain definite substances, varying according to the nature and function of the cell. In other words, the chemical substances forming the pabulum of these vegetable cells will undergo a constant and definite series of changes, which we know by the name of FERMENTATION.

As we have already seen, fermentation is due to the entrance into the fermentescible material of particles from the outer world. The origin of micro-organisms in similar substances is also due to the access of particles from the outer world. Micro-organisms are always present in fermenting fluids. Micro-organisms must produce a change which comes within the definition of "Fermentation," as the result of their growth in these materials. The precautions which exclude micro-organisms from organic substances also exclude the particles which cause fermentation. Where one set of particles is admitted, the other also enters; one cannot get fermentation without the presence of micro-organisms, nor the presence of micro-organisms without fermentation. The fermentations of which we speak are not instances of chemical decomposition; they do not correspond to the change produced by ptyalin, pepsin,

etc.; the ferment increases in quantity, and the fermentation takes a considerable time to be completed; it is evidently a vital phenomenon. These facts of themselves would surely lead to the conclusion that the particles which give rise to micro-organisms, and those which cause fermentation, are one and the same; that in fact fermentation is the result of the growth of micro-organisms in fermentescible materials. Numerous facts show that this is so, but into the consideration of these I need not enter. It is now universally admitted that the *aleoholic* fermentation is due to the growth of the yeast-cell in the sugary solution, and that the formation of *vinegar* is due to the growth of the so-called "Vinegar plant." Numerous similar facts have been demonstrated with regard to other fermentations. The formation of numerous pigments on boiled potatoes and other suitable soil, is due to the growth of forms of micrococci and bacilli; and the same is true of blue milk, blue pus, etc. Pasteur has brought forward remarkably interesting facts with regard to the *butyric* fermentation. Mr. Lister has absolutely demonstrated that the *lactic* fermentation of milk is due to the growth of a special form of bacterium in the milk.¹ Numerous experiments have also been performed which demonstrate that the *putrefactive* fermentation is no exception to the general law, and that it also is due to the growth of micro-organisms.

ANTISEPTIC AND ASEPTIC SURGERY.

Since, then, the fermentation of the discharges of wounds is due to the growth in them of micro-organisms, which bodies come from the outer world, it is evident that surgery which acts against the causes of fermentation, that is, ANTISEPTIC SURGERY, may be carried out in various ways. It is not merely confined to the *exclusion* of organisms, but it may work by permitting their entrance, and neutralizing their power afterwards. This is the most common way in which antiseptics are employed at the present time. They are added to the discharge, and their usefulness depends on the extent to which they interfere with the growth and fermenting power of the micro-organisms which have entered the discharge, without at the same time being hurtful to the wound. The latter is an important point, and it is for this reason that carbolic acid is one of the least satisfactory antiseptics when employed in this way. For it irritates the wound, thereby giving rise to increased discharge; while, on the other hand, it requires to be present in large amount, in albuminous materials, in order to arrest or materially interfere with fermentation. The former effect of carbolic acid defeats the latter aim, and thus, where carbolic acid has not been used *aseptically*, that is, with the view and with the result of excluding micro-organisms from wounds altogether, it has been found to be inefficient, and by no means a satisfactory application. The free *drainage* of wounds is also an antiseptic method, for by it the discharge is carried away from wounds before micro-organisms have time to develop in it, or to alter it to any extent. At the same time, it is a method liable to fail if anything interferes with the drainage, for as the causes of fermentation are constantly present, they develop, if for any reason the discharge collects in the wound. Among the most important antiseptic measures is treatment by *irrigation*, or by the *water bath*. In treatment by irrigation, the discharge is not merely permitted to flow away, but it is washed away as fast as it forms, and thus there is less chance of development of micro-organisms than where free drainage alone is employed. The antiseptic virtues of this method are much increased by using an antiseptic lotion for irrigation. Treatment by the water

¹ Transactions of the Pathological Society of London, 1878.

bath can hardly be as effectual as by irrigation, for the discharge is not removed with the same certainty and rapidity. The *open method* of treatment must also be included among the antiseptic methods, though at first sight it might appear entirely opposed to them.

The free exposure of the discharge to the air acts antiseptically in two ways. In the first place, it was pointed out by Pasteur long ago, with regard to the alcoholic fermentation, that the fermenting power of the yeast cells was much diminished if they were freely supplied with oxygen. On the other hand, if they had but little oxygen, they, according to his theory, took it from the sugar, and caused fermentation much more rapidly and thoroughly. Therefore, any micro-organisms requiring free oxygen for their growth, though they grow more rapidly, will produce less fermentation, if the discharge be well oxygenated, than if it be shut up under a mass of dressings. But Pasteur also showed, with regard to the butyric and putrefactive fermentations, that oxygen was directly noxious to the bacteria which caused them; that not only could these fermentations not occur if oxygen were freely admitted, but that the bacteria were actually killed by this gas. Thus the free exposure of the discharge to oxygen diminishes the fermenting powers of those micro-organisms which grow in it, while it prevents the development of those which cause one of the most obnoxious fermentations—the putrefactive. In the second place, the open method acts antiseptically in another way. For by the free exposure of the discharge to the air, evaporation takes place, and the fluid becomes more concentrated. Now bacteria do not develop nearly so well in a concentrated as in a moderately dilute solution, and fluids may be made so concentrated that bacteria will not develop in them at all. This concentration of the fluids is carried to its most complete extent in the treatment by crust formation, and it acts to some slight extent in Alphonse Guérin's cotton-wool dressing, though that hardly deserves to be included among antiseptic methods. A very different, but equally important principle is involved in the method of treatment by accurate approximation of cut surfaces, and the maintenance of perfect mechanical rest. It is well known that wounds of the face unite readily by first intention, without the occurrence of fermentation in the layer of lymph or blood-clot between the cut surfaces. This implies one of two things: either lymph is a medium in which micro-organisms can only develop with difficulty, or else the healthy living tissues have the power of preventing the development of micro-organisms in their substance and immediate vicinity. That the latter is the case, has now been amply demonstrated, and it is the chief agent at work in getting this result. At the same time, lymph is not by any means the best pabulum for isolated bacteria.

ASEPTIC SURGERY AND LISTERISM.

It is, of course, at once evident that all these methods must stand far below the great principle which Mr. Lister was the first to enunciate, and to the application of which in surgical practice he has devoted so many years. When Mr. Lister first wrote on this subject, the confusion and uncertainty which existed in the minds of surgeons on this matter, was, as I have just indicated, very great, and the results obtained by him in all cases stood forward in glaring contrast to the results got at that time from the misdirected efforts of other surgeons. Since he wrote, however, and to a great extent by his own writings, interest has been excited in this department, and improvement has followed, not merely in the method of treatment which he devised with the view of excluding micro-organisms altogether from wounds, but also in the less perfect forms of antiseptic surgery to which I have referred in the preced-

ing paragraph. Indeed, so good have the results become in ordinary cases treated antiseptically by one or other of the methods mentioned, though not *aseptically* (that is, on the Listerian principle),¹ that some surgeons are inclined to the view that aseptic surgery is unnecessary in a great many cases, being only required for certain special operations. This view is, however, erroneous and mischievous, for by no method other than the aseptic method have infective diseases been entirely abolished; in cases treated by other forms of antiseptic surgery, they occur every now and then, and the surgeon cannot leave their possible occurrence out of account in determining the expediency of an operation. That certain operations are only justifiable when full precautions are taken to exclude micro-organisms, is now admitted by all. Such operations are incisions into joints, opening of psoas abscesses, operations on healthy bones—as for ununited fracture, etc. That such operations are perfectly safe when done with proper aseptic precautions, is also abundantly proven. As the aseptic method can protect the patient under these circumstances, it can also protect him in ordinary cases, and, therefore, if one desires to be perfectly certain of avoiding infective disease in any given case, he must employ the aseptic method. But as it is the duty of the surgeon to prevent every possible risk in every case, it is, therefore, his duty to employ aseptic treatment whenever he can. And even supposing that the other methods were perfectly reliable in ordinary cases for the purpose of saving life, there are other advantages in the aseptic method which require its employment. By its use the patient is often saved a great amount of pain, and healing is very rapid and certain; while, on the other hand, patients treated in other ways, if they do recover, often do so only after a severe struggle for life. Many other advantages might be mentioned, but these I need not detail here.²

In speaking and thinking on this subject, great care must be taken to distinguish between ASEPTICISM and the ASEPTIC METHOD. Asepticism is synonymous with Listerism; it is the great principle, first enunciated by Mr. Lister, that the causes of fermentation in wounds are particles from the outer world, and that in order to abolish the risks due to fermentation in wounds, the proper method of treatment is to prevent the entrance of the living causes of fermentation into them. The aseptic method is synonymous with the Listerian method. It is the best way at present known of securing this result. When, as of late has happened, Mr. Lister gives expression to the view that perhaps the time is not far distant when some of the means at present employed in his method may be abandoned, the cry is raised that “Listerism is dead.” Such an idea rests on mis-appreciation of what Listerism is. Listerism or asepticism is a great principle which has triumphantly withstood the most searching tests, and which is now a law of the first importance to the practical surgeon. The Listerian or aseptic method is the best means at present known of carrying out that law in surgical practice, but the means have always been improving, and must always continue to improve. The time may indeed come when the method shall have undergone an entire alteration, but, nevertheless, the principle underlying it will always remain the same. Whatever changes may occur in the present Listerian method, Listerism will always remain the most fundamental prin-

¹ As will be evident from what has gone before, there are a variety of forms of *antiseptic* surgery, that is, of wound treatment directed against the causes of fermentation, and the method used by Mr. Lister for the total exclusion of micro-organisms, is only one form. To retain the term “antiseptic surgery” for this method alone, is to introduce confusion, and it seems better, therefore, to abandon it, and to speak of Mr. Lister’s method as the *aseptic* method, for it aims at, and succeeds in, excluding the causes of fermentation altogether from the wound; that is, it renders the wound *aseptic*.

² For full details on these and other points, see my work on “Antiseptic Surgery; its Principles, Practice, History, and Results.” London, 1881.

ciple of wound treatment, and the surgeon when he makes a wound will "lister" it in the fullest sense of that term. The same thing has occurred with all natural laws; when once discovered and firmly established they remain immutable, but the practical applications of them are constantly widening and improving.

As the other methods of antiseptic surgery have already been detailed in a preceding article, it only remains for me to describe the best means at present at our disposal for carrying into effect the great Listerian principle. At first the means employed were quite simple: some pure carbolic acid was poured into the wound, and, mixing with the blood, formed a crust; or the crust formation was assisted by the addition of lint; and under the protection of this crust the wound healed. Numerous disadvantages were found in this method, and many alterations and additions were made, till at length the present form was established, and has been employed satisfactorily for several years.

THE ASEPTIC METHOD.

In order to have an aseptic state of a wound, a number of points must be attended to. In the first place, during the performance of an operation care must be taken to prevent the entrance of organisms. The skin of the patient is everywhere covered with dust which contains numerous active causes of fermentation. These must, therefore, be destroyed, as otherwise the operation would be entirely vitiated. On the hands of the surgeon and his assistants there are also numerous causes of fermentation, which must also be removed. The same is the case with all instruments, etc. Sponges must not be washed in water: indeed water contains perhaps more numerous causes of fermentation than ordinary air dust, and therefore it must not be employed at all. And the air itself, though in a much smaller degree than the deposited dust, contains some causes of fermentation which must also be guarded against. Then, after the operation has been performed, care must be taken to prevent the access of micro-organisms; this is done by the use of a suitable dressing, which imparts to the discharge, as it flows out, sufficient of the antiseptic stored up in it to render the discharge an unfit soil for the growth of micro-organisms. After a time the antiseptic contained in the dressing becomes exhausted, and must be renewed. When this is done, the same care must be taken not to introduce any septic dust as during the operation.

The antiseptic which has been chiefly employed up to this time, and which has proved most satisfactory, is *carbolic acid*. For the purification of the skin, either of the patient or of the operator, a watery solution, of the strength of one part of the pure acid to 20 parts of water, is employed. The skin over, and in the neighborhood of, the intended wound, is thoroughly washed with this solution, which must be allowed to act for some little time, because the antiseptic has to mix with the fatty matters, and to penetrate into the folds of the skin, while at the same time some of the micro-organisms may be peculiarly resistant, and may require a considerable time for complete destruction. In cases in which poultices have been employed, or in which there is an accumulation of putrid material on the skin, it is well, after washing the skin thoroughly with this lotion, to wrap a cloth soaked in it around the part, and leave it on for fully half an hour before the operation.

For the purification of the *hands* of the surgeon and of his assistants, in the first instance, if the operation be an important one, as, for example, on a joint, or opening an abscess, it is well to use the same strong solution of carbolic acid, and care must be taken that the whole hand is thoroughly washed

with the solution. It is not sufficient merely to *dip* the tips of the fingers or even the whole hand in the solution; care must be taken that all the folds of skin, more especially about the nails, be acted on, and particularly that the solution pass up under the nails. In ordinary wounds, the 1-40 watery solution of carbolic acid is sufficient, and it does not benumb the hand, as the stronger solution is apt to do.

For the purification of the *instruments*, the 1-20 solution is employed. A large porcelain or tin trough is provided; the instruments to be employed are laid in this, and then it is filled with 1-20 solution. In hospital practice, this is generally done from a half to one hour before the operation takes place. When toothed instruments, or instruments closing with catches, are used, it is best to separate the blades, so as to allow the lotion to get in between the teeth. It is well to immerse the whole of the instrument, for if only the point, for example the blade of a knife, is purified, the surgeon may inadvertently introduce the handle into the wound without washing it with the solution, and he may thereby introduce septic dust.

The *sponges* are washed in the 1-40 carbolic solution. After the operation, they are rinsed in water, and then placed in a jar of 1-20 solution till required again; then the 1-20 solution is squeezed out, and the sponge, when washed in the 1-40 lotion, is ready for use. These sponges may be used for a long time, till, in fact, they wear out. In some cases they get clogged with fibrine. To get rid of this, the sponge is placed in a trough containing water, and left for some days. The fibrine putrefies, and can then be washed out readily. The sponge is then placed in a jar containing the 1-20 carbolic lotion, and is ready for use when required.

The purification of the air is effected by means of a *spray* of carbolic acid. The spray is produced by driving a rapid current of air through the narrow orifice of a horizontal tube, which is placed over the orifice of a more or less vertical one. The air rushing over the opening in the vertical tube, sucks the air out of that, and, if the lower end dips into a fluid, the fluid is sucked up and expelled from the narrow orifice in the form of finely divided particles, or spray (Fig. 231). At present, steam sprays are employed. They consist

Fig. 231.

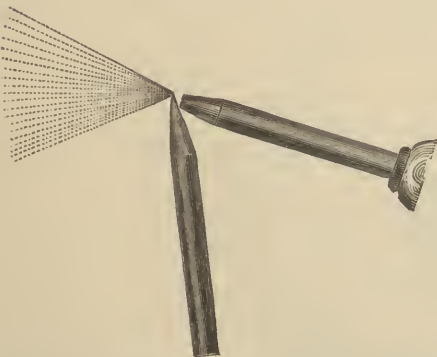
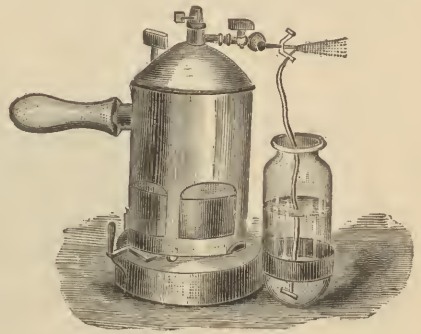


Diagram to show the principle of spray producers.

Fig. 232.



Ordinary steam spray producer as at present employed by Mr. Lister.

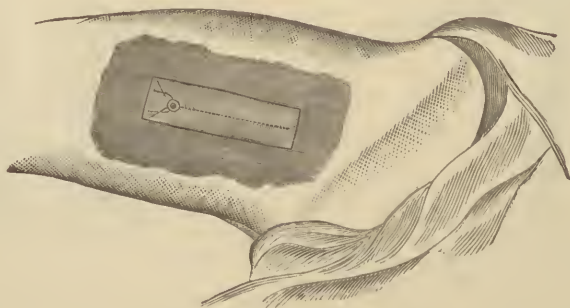
of three parts: a boiler, containing water; a lamp, placed beneath this boiler; and a retort, containing carbolic lotion. The steam generated in the boiler passes along a horizontal tube, sucks up the lotion through a vertical tube connected with the retort, and, mixing with it, forms the spray (Fig. 232). The fluid in the retort is the 1-20 watery solution of carbolic acid, and this,

mixing with the steam, forms a spray of the strength of about 1 part of carbolic acid to 30 parts of water. The spray is employed during the whole operation; till in fact the dressing has been securely applied.

With the view of excluding organisms after the operation, the material usually employed is the *carbolic gauze*. This is ordinary tarlatan, impregnated with a mixture of 1 part of carbolic acid, 4 parts of resin, and 4 parts of paraffin. If the cotton material were merely dipped in carbolic acid or carbolic lotion, the antiseptic would very quickly volatilize, or be washed out by the discharge. It is necessary, therefore, to have the antiseptic stored up so that it may last for some time. This is the purpose of the resin. Resin and carbolic acid have a much greater affinity than water and carbolic acid. Water, therefore, may pass over a mixture of resin and carbolic acid for a considerable time, without washing out all the antiseptic. If the gauze were impregnated with resin and carbolic acid alone, it would be so sticky as to be useless, and therefore paraffine is added to it in sufficient quantities to do away with its stickiness. As the gauze at ordinary temperatures does not give off much carbolic acid, dust which falls on it is not deprived of its fermenting property, and, if a piece of gauze covered with dust is applied over the orifice of a drainage tube, this dust may pass into the wound, and entirely defeat the object of the whole treatment. On the other hand, the watery solution of carbolic acid acts very rapidly, and hence all that is necessary is to dip the layers of the gauze which go next the wound in the 1-40 lotion. Lest the carbolic acid should evaporate, the gauze, if it is to be kept for some time, is preserved in closely-shutting tin boxes.

Carbolic acid is a powerful irritant, and, applied directly to a wound, it will retard or even prevent healing. With the view of overcoming this difficulty, Mr. Lister interposes a material, impervious to carbolic acid, between the wound and the gauze dressing. This material is termed the *protective*. It is ordinary oiled silk, coated on both sides with a thick layer of copal varnish. Outside this a solution of dextrine is brushed, because water runs off from the material without the dextrine, just as from a duck's back, whereas the dextrine dissolves in the lotion, and the protective is equally and perfectly moistened. This protective is cut a little larger than the wound, dipped in the lotion, and applied over it. Outside the protective we have the wet gauze, larger than the protective and overlapping it in all directions, both together being called the *deep dressing* (Fig. 233).

Fig. 233.



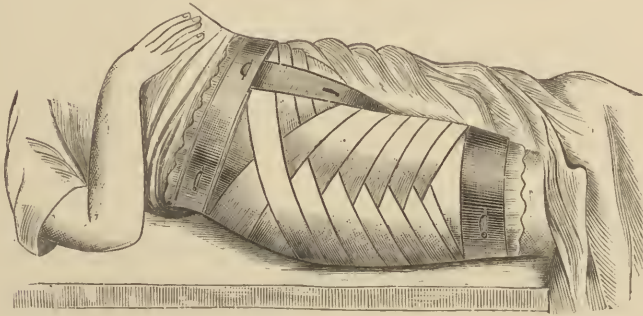
Shows the method of using the protective and deeper layer of the gauze.

When used as a dressing, the carbolic gauze is packed into the hollows around the wound, and then a regular dressing is applied. This consists of the *gauze* folded in eight layers, beneath the outer layer of which is placed a piece

of *mackintosh* cloth, what is known as "hat lining." The object of this is to make the discharge traverse the whole of the dressing, and not pass directly through, as would be the case were the mackintosh absent. If there were no mackintosh, the discharge, always passing through one part, would wash out all the antiseptic in a very short time, and putrefaction would rapidly occur. To avoid this risk a large quantity of gauze would be necessary, and this would increase the expense of the treatment very much, whereas, by the use of the mackintosh, the discharge is made to pass from the centre to the edge of the dressing, that is, through a mass of gauze equal in thickness to the distance from the centre to the edge of the dressing. The same piece of mackintosh may be used several times, till in fact it wears out. After the dressing has been removed, it is taken out, sponged with carbolic lotion, and introduced into the new dressing. A patient is provided with two pieces at the commencement of the case, and these are generally sufficient, one being made up in a fresh dressing while the other is being used. Thus, though an expensive material, yet when divided over a number of dressings, its expense becomes very little. Expense is also saved by preserving the large pieces of gauze used in the dressings. They may be washed and recharged with the carbolic acid mixture. These dressings should be large, and should overlap the wound for a considerable distance in every direction.

The dressing is fastened on by a *bandage*. This may be made of carbolic gauze, which is light, cheap, and useful in many ways. But a cheaper bandage and one sufficiently convenient, indeed more convenient than the carbolic gauze bandage in many cases, may be made of thin muslin. As the dressing may not remain closely applied to the skin during all the movements of the patient, more especially in the neck, chest, or groin, there is a certain risk that air unacted on by the antiseptic may pass under the dressing and reach the wound, carrying active septic dust along with it. This danger is obviated by applying an *elastic bandage* along the edge of the dressing (Fig. 234). This

Fig. 234.



Dressing in a case of abscess of the hip-joint, showing the extent of the dressing and the arrangement of the elastic bandage around its edges.

may be put sufficiently on the stretch to keep the edge of the dressing accurately in contact with the skin, without pressing injuriously, or interfering with the circulation in the part. Pins are put in along the edge of the dressing, fastening the dressing and the bandages together at the important points. Safety pins are the best for this purpose, as common pins are apt to get buried and lost in the gauze.

APPLICATION OF THE ASEPTIC METHOD TO OPERATIONS.

Let us now suppose that an operation is about to be performed with aseptic precautions. The following materials will be necessary :—

- (1) One to twenty and one to forty watery solutions of carbolic acid ;
- (2) A trough containing the instruments, which are soaking in the 1-20 carbolic lotion ;
- (3) Sponges ;
- (4) Basins containing 1-40 carbolic lotion in which to wash the sponges ;
- (5) Vessel containing 1-40 carbolic lotion, for use during the operation, for the repurification of hands or instruments ;
- (6) Towels soaked in 1-20 carbolic lotion. Mackintoshes.
- (7) A largish piece of muslin soaking in 1-40 carbolic lotion, and termed the "guard;"
- (8) A basin containing 1-40 carbolic lotion, in which a piece of protective and loose gauze are soaking ;
- (9) A steam spray apparatus ;
- (10) A vessel containing 1-20 carbolic lotion, for the purification of the skin of the patient and of the operator ;
- (11) Catgut ;
- (12) Drainage-tubes of various size ;
- (13) Horse-hair for drains and stitches ;
- (14) Carbolyzed silk for stitches ;
- (15) Silver wire for stitches ;
- (16) Lead buttons for "button stitches;"
- (17) Loose gauze ;
- (18) Gauze dressing ;
- (19) Bandages, muslin, and gauze ;
- (20) Elastic bandage ;
- (21) Safety pins.

N. B.—No water must be used.

The patient having been placed on the table, mackintoshes are arranged so as to prevent soiling of the clothes, and around the part to be operated on, and over the clothes and mackintoshes in the vicinity, towels soaked in 1-20 carbolic lotion are fixed. The object of these is that, should the surgeon lay down any instruments which he is using, he may lay them down on a pure basis, and may be sure that they will not take up any septic material from the place where they lie, while at the same time, should any of the clothes come in contact with the wound, it is protected from harm by having this pure layer interposed. The skin of the patient and that of the operator having been purified in the manner already described, a spray of carbolic acid is made to play on the part from a suitable distance (about six feet). If the spray be too near, it is unnecessarily wetting, while it is so narrow that the hand of the operator and his assistant will be constantly getting out of it. The spray is, on the other hand, perfectly efficient at a considerable distance; it is not wetting; and there is plenty of room for working in it.

A basin containing 1-40 carbolic lotion is placed between the wound and the operator, and in this he can repurify his hands or his instruments should they have been contaminated with septic dust, either from the clothes, or by holding them outside the spray. All instruments, sponges, etc., must be handed into the spray, because every time that the operator has to reach his hand out of the spray, it comes in contact with septic dust, and must be repurified in the carbolic lotion before being introduced again into the wound. If the spray is to be used at all, these precautions are necessary.

There can be no doubt that the spray is the least essential of all the details

of the Listerian method. For, in ordinary air, there are comparatively few particles capable of causing fermentation. At the same time, there are particles, and, as we cannot know where such particles are, if we are to take the precaution of purifying the air, it must be done thoroughly, as if the air were full of these particles; and every time that the hands of the operator or his instruments have come in contact with unpurified air, that is, have been passed outside the spray, they must be repurified in carbolic lotion, before being reintroduced into the wound. The spray is a convenience, not a necessity. Aseptic treatment can be carried out without a spray; indeed for several years Mr. Lister did not use it. If, however, no spray is employed, we must not forget that septic particles are still present in the atmosphere, and must still be destroyed. This is done by washing out the wound every now and then during the course of the operation with carbolic lotion; and, after stitching up the wound, it is well to syringe it out immediately before applying the dressing. Of course all the other precautions must be observed. In some cases, as in empyema, the spray is almost a necessity, and in all it is more convenient and more certain than the method of washing out the wound. The steam spray acts automatically. Once put in action, it goes on of itself. By its use there is no necessity for applying the irritating carbolic solution to the wound. To wash out the wound with carbolic acid, is to irritate it very much, and in some cases to interfere with the chance of primary union; at the same time, it causes an increased amount of serous oozing, which, of course, tries the antiseptic dressing very much, washing out the antiseptic, and increasing the risk of putrefaction during the after-treatment. It is, however, well to bear in mind that, where no spray is at hand, the aseptic method may still be carried out, and that the spray is the least essential part of the method as at present employed. *The most essential part of the treatment is the thorough purification of everything (hands, instruments, etc.) which comes in contact with the wound. The introduction of an unpurified instrument into a wound is a much worse error, and one far more likely to be followed by bad results, than the momentary deflection or cessation of the spray.*

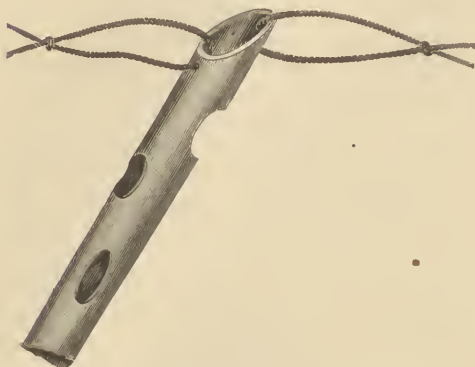
When, for any reason, it is necessary to stop the spray for a time during an operation, the wound may be protected in the interval by throwing over it a piece of muslin soaked in carbolic lotion, and termed "the guard." The guard is also used in the case of a large wound where the spray does not quite cover the whole of the wound. In this instance, the guard is thrown over the part of the wound on which the surgeon is not working, and the spray is directed over the rest of it.

The operation having been performed with the precautions detailed, the hemorrhage must be arrested. This is done by means of ligatures of *carbolyzed catgut*. There are two kinds of catgut which are at present employed: the *carbolyzed* catgut, which was that first introduced by Mr. Lister;¹ and the *chromic acid* gut, which lasts longer in the tissues than the former, and is more rapidly and easily prepared.² All bleeding points are tied, and the ligatures cut short. There is no excuse for leaving any bleeding vessel, as the ligatures cause no trouble afterwards.

The *drainage* of wounds treated in this way is a most important point. It may be accomplished by means of drainage tubes, or by capillarity. The *drainage tubes* employed are made of vulcanized India-rubber (Fig. 235), and are of various sizes. They are introduced to the deepest part of the wound, and are cut flush with the surface at the outer end, obliquely if the tube be oblique, and transversely if the tube runs directly inwards. To permit the

discharge to escape from all parts of the wound, circular holes are cut in the sides of the tube, at intervals, the diameter of each hole being about one-third of the circumference of the tube. To prevent the orifice of the tube from becoming displaced, loops of carbolized silk, knotted at the end, are

Fig. 235.



Ordinary drainage tube.

passed through the outer part of the tube, and the knots, lying between the skin and the dressing, prevent the orifice of the tube from becoming displaced. Should there be a great tendency for the tube to slip in, the loops of silk may be filled with wet carbolic gauze. The orifices of the tubes are generally placed at the most dependent part of the wound, but this is not essential. For as long as there is a free opening for the exit of the discharge, it may simply be allowed to well out, because the discharge is unirritating, and, therefore, the quantity filling up

the tube does no harm; at the same time, where possible, it is well to have a dependent opening. The chief point to be observed in determining the position of the orifice of the drainage tube, is to have it as far removed as possible from the edge of the dressing. Thus, in an operation for inguinal hernia, the orifice of the tube is not placed at the most dependent part, near the penis, because there would be very little space for overlapping of the dressing, but it is arranged at the uppermost angle of the wound, as far away as possible from sources of putrefaction. These drainage tubes are always kept ready for use, in a vessel containing 1-20 carbolic lotion. When a drainage tube is removed finally from a wound, it is washed in carbolic lotion, placed in the jar with the other tubes, and is then ready for use when required for another case.

It is well to leave a tube undisturbed for three days after an operation. If it be taken out sooner, there will often be difficulty in reintroducing it, but by the third day the tissues will have become condensed, and the tube will be lying in a comparatively firm channel, which will not collapse when the tube is removed. When it is taken out, it is washed in the solution, and, if it projected from the wound, a piece corresponding in length to the projecting portion is clipped off from the inner end, and the tube is then reintroduced. Frequently, on the third day, a smaller and shorter tube may be used. No definite rule can be given as to the best time for dispensing with the tube altogether. When the discharge is very little, and when the channel is comparatively straight, and not likely to become obstructed, the tube may be removed. This must, however, in the main be a matter of experience.

Drainage by *capillarity* was first tried by Mr. John Chiene, of Edinburgh. He combines with it the principle of using absorbable drains. The material which he employs is *catgut*; several threads are brought out at a part of the wound, and the fluid flows out in the intervals between the threads. By using *catgut* he also avoids the necessity of removing the material employed for drainage, because the *catgut* becomes absorbed in a few days. Mr. Chiene stitches the centre of a skein of *catgut* to the deepest part of the wound by means of a *catgut* stitch, so that the drain cannot become displaced. He then breaks up the skein into bundles of six or eight threads each, and brings these out at various points along the line of incision. In a few days, the

portions of the threads projecting from the wound fall off, and the point of exit cicatrizes. This method of drainage is very satisfactory in some cases, but the chief objection to it is that the catgut is apt to become absorbed too soon, before, indeed, a drain can be dispensed with. How far the new chromic acid catgut will obviate this difficulty remains to be seen. In some cases, *horsehair* has been employed instead of drainage tubes, and it answers very well where the discharge is purely serous. It has, however, the same objection as drainage tubes, that it requires to be removed; and there is a further objection, that it is not as easy to reintroduce it as it is to reinsert a drainage tube. In some instances, however, it affords the best means of drainage; for example, in situations where a tube might be liable to become compressed and obstructed, as in a joint. Dr. Neuber¹ has quite recently applied Chiene's principle of absorbable drains to drainage tubes. He *decalcifies bones*, drills a central hole in them, and cuts lateral holes just as in ordinary drainage tubes. These tubes, like Chiene's catgut drains, become absorbed in a few days, and answer very well in some cases.

The *stitching* of the wound is a matter of the greatest consequence with a view to rapid healing. In wounds treated antiseptically, provided that the

Fig. 236.



Button stitch.

drainage be properly arranged, the edges of the skin may be brought very accurately together, even where a large piece of skin has been removed, and

Fig. 237.



Shows the three kinds of stitches in a wound, and the arrangement of the drainage tube.

where, therefore, there is considerable tension. To relieve the edges of the skin from this tension, and at the same time to allow them to be brought into accurate contact, *lead buttons* are employed in the following manner: A needle carrying a strong piece of wire, to the end of which a button is attached in

¹ Archiv für klinische Chirurgie, Band xxiv.

the way shown in Fig. 236, is introduced at some distance from the edge of the skin, carried through the wound, and brought out at a similar distance from the edge on the other side, where it is secured by a second button. Two or three pairs of these "*button stitches*" are inserted; these bear the strain, leaving the edges of the wound to be easily united by suitable stitches. In some cases, there is still a little difficulty in bringing the parts together, in which contingency thick silver wire stitches are inserted at intervals, taking a deep and broad hold of the tissues, and being termed "*stitches of relaxation*;" and then the margins of the skin in the intervals between these are brought into exact apposition by stitches of carbolized silk, horsehair, or catgut. These latter stitches receive the name of "*stitches of coaptation*." (Fig. 237.) In this way union by first intention may be got in cases where, at first sight, it seemed impossible, even by the most violent traction, to get the edges of the skin into apposition. The carbolized silk, which is used for stitches, is prepared by dipping ordinary ligature silk into a melted mixture consisting of nine parts of beeswax and one part of carbolic acid. The ligature is wound on pieces of lead, and kept in stoppered bottles.

Having now completed the operation, the surgeon proceeds to apply the *dressing*. A piece of protective, of suitable size, is laid over the wound, and this is overlapped in all directions by a mass of gauze wet in carbolic lotion. This arrangement goes by the name of the "*deep dressing*." In wounds close to the pubis, or the mouth, or, indeed, in any situation where there is but little room for the overlapping of the gauze dressing, it is well not to use the protective, because it prevents the carbolic acid in the gauze from reaching the discharge beneath it, and, therefore, if the gauze only extends a little beyond it, the discharge may not receive enough of the antiseptic to prevent it from putrefying. In any case, only as much protective as is necessary to protect the healing margin should be employed, and great care must be taken that it nowhere reaches to a point beyond the edge of the dressing, as the protective is only meant to protect the cut edges, and thus permit healing to occur; it is not used in cases of abscess, where there is only a drainage tube and no cut edge. All hollows are filled up with loose gauze, and special masses of gauze are applied where most discharge is expected, and then the general gauze dressing is fastened on as before described.

The dressing is always changed on the day following the operation, and afterwards the rule is that, if, at the hour of the ordinary visit, discharge is found at the edge of the dressing, it is changed; if not, it is left till the next day, when the same rule is followed. The dressing is never left longer than a week unchanged. In changing the dressings, the spray is used. After removing the elastic and common bandages—during the time required for which the patient or an assistant places his hand on the dressing, over the wound, to prevent it from being accidentally exposed—the spray is turned on, and the edge of the dressing next the spray is lifted, so that the spray passes in between the dressing and the skin. There is no necessity for washing the wound. A fresh piece of protective and wet gauze are at once applied, and then the skin all around is thoroughly washed with the lotion. Loose gauze and a fresh dressing are then arranged. The rules with regard to the drainage-tubes have been already indicated. The stitches are removed when the line of incision has healed, or sooner, if any of them are causing irritation. In removing the stitches, those of *coaptation* are first taken away; then, a day or two later, the stitches of *relaxation*; and lastly, when the parts are soundly united, the *button-stitches*. This, like the manipulation of the drainage-tubes, must be learned by experience. Where dressings are to be left on for several days, it is well to rub a little salicylic acid around the wound. This is most

conveniently done by using the acid mixed with carbolic glycerine, of the consistence of cream. This has the effect of preventing the troublesome eczema which sometimes occurs under dressings left on for some time.

If the surgeon does not have a spray at hand for the purpose of changing the dressings, its use may be rendered unnecessary by the employment of catgut drains and catgut stitches, and by fixing down the deep dressing so that the wound is not exposed when the outer dressing is removed. This deep dressing is treated like a wound, is washed with the lotion and covered with a piece of wet gauze overlapping it in all directions, and a fresh dressing is applied. If it be necessary to expose the wound, it is well, by means of a syringe, to let a current of carbolic lotion flow over it when it is exposed. In some cases, especially in country practice, it is desirable to leave the dressing unchanged for some days. This may be done in various ways, but perhaps the best is by the application of large masses of carbolic, salicylic, or iodoform jute, as recommended recently by Dr. Neuber.

Wounds near the *rectum* may be treated aseptically, but here the carbolic gauze is not applicable. For this purpose carbolic acid and oil, or carbolic acid and glycerine, 1-10, is employed. This is especially useful in cases of abscess near the anus. The abscess is opened under the spray, and, instead of a drainage-tube, a narrow strip of lint dipped in 1-5 carbolic oil is introduced. Then, outside this, is applied a mass of lint dipped in the glycerine and carbolic acid, which is fastened by a T-bandage. For some days the patient's bowels are kept at rest by opium, and afterwards, when he defecates, he holds the pad over the wound with his hand, defecates past it, washes the part with some 1-20 carbolic lotion, and pours fresh glycerine on the lint, or applies a new piece.

THE ASEPTIC METHOD APPLIED TO WOUNDS NOT MADE BY THE SURGEON.

These wounds are essentially of two classes: those which come under treatment at once, or within a few hours; and those which are not seen for some days after their infliction, till, in fact, fermentation has become firmly established.

I. WOUNDS WHICH COME UNDER OBSERVATION EARLY.—Here the problem is different from that which we have been considering. As yet we have merely had to exclude micro-organisms from wounds, but in these instances they have, in many cases, already entered, and we must extirpate them, and keep them out afterwards. To extirpate them, the wound is washed out with 1-20 carbolic lotion, or, in cases in which some hours have elapsed since the infliction of the injury, with 1-5 solution of carbolic acid in rectified spirit. Let us take, for example, a case of compound fracture. Here we have a complicated wound; air and dust may have been sucked into all its recesses, and have mixed with the blood-clot. The end of a gum-elastic catheter, connected with a syringe, is introduced into the wound, and the purifying solution is driven in through this. By means of the catheter, the carbolic lotion can be introduced into all the recesses of the wound. Care must be taken to leave the external wound freely open, so that the injected fluid may escape readily, for otherwise there would be a danger of the fluid penetrating among the layers of the cellular tissue, and causing inflammation, or even gangrene. It is well to squeeze out all the blood-clots. The drainage of the wound is next attended to, and, if necessary, the external opening is enlarged. The fragments are then brought into position, and the protective, wet gauze, and

gauze-dressing applied as usual. After a few days, the limb may be put up in plaster of Paris or other suitable material, a window being left for the daily application of fresh dressings. There are many other ways in which the limb may be fixed, space being provided for aseptic dressings; but these must be left to the ingenuity of the surgeon.

Some wounds may be stitched up, care being taken to provide for drainage, but, unless in the case of clean, incised wounds, it is better to leave the whole wound open, for otherwise there is apt to be inflammation, or even sloughing of the edges of the wound, and thus the state of matters is by no means improved.

Lacerated wounds behave beautifully under this treatment. The wound is thoroughly purified by scrubbing it well with carbolic acid, and then the salicylic cream, mentioned before, is applied in considerable quantity. Then a deep dressing is fixed on, and left undisturbed for some days. When the superficial dressing is changed, this deep dressing is treated like a wound, as described before. After a week or ten days, the deep dressing may be removed, and a fresh one applied. In this way a badly lacerated wound may heal without any suppuration or sloughing of the torn parts. Blood-clot fills up the wound, and remains there. In the deeper part of this clot, and in the deeper parts of the dead tissues, organization occurs by infiltration of young cells, and cicatrization takes place under the superficial layer of the clot, so that frequently, after a time, a superficial layer of blood-clot may be peeled off from above, and a cicatrix be found beneath.

Gunshot wounds may also be treated aseptically, and often with great success.¹ Reyher's experience in the recent Russo-Turkish war led him to the conclusion that the aseptic treatment of these wounds might be carried out in two ways, according to the state of the wound and the nature of the injury. If the wound was gaping, or if there was any reason to suspect that the bullet, in its course, had carried along with it portions of clothing or other extraneous material into the interior, it was necessary to wash out the wound with carbolic lotion after the manner described under compound fractures. When possible, the bullet was extracted. The skin around the wound was also purified with the 1-20 lotion, and a large antiseptic dressing of carbolic gauze or salicylic wool applied. This treatment was also necessary in all wounds caused by a ball or shell, which were of course lacerated wounds. In cases where there was no reason to suppose that the bullet had carried in any foreign matter along with it, and where the edges of the wound were lying in contact, this treatment was unnecessary, and it was sufficient to disinfect merely the orifice of the wound and the surrounding skin, and to apply a suitable antiseptic dressing. In carrying out this treatment, the spray is not necessary, but, if it is at hand, it is a great convenience, and renders the result more certain.

Burns may also be treated in some cases aseptically. Where the burnt surface is not extensive, an attempt should be made to purify it by washing it with 1-20 carbolic lotion. Then, if it be small, full strength boracic ointment of the following composition may be employed. (Make a basis of 2 parts of paraffine and 1 part of vaseline. Take of this 5 parts, and of boracic acid crystals 1 part. Mix.) Outside the ointment, which is spread on a piece of linen, several layers of boracic lint are applied. Where the burn is more

¹ See Reyher on "Die antiseptische Wundbehandlung in der Kriegschirurgie." Volkmann's Sammlung klinischer Vorträge, Nos. 142 und 143, 1878.

extensive, and in cases in which, as a consequence, the use of carbolic acid would be dangerous, wet boracic lint dressing, that is, boracic lint used as water-dressing, is employed. Carbolic oil may be used in some cases, but, if the burnt surface is large, there is apt to be a fatal absorption of carbolic acid. Afterwards, the same dressing is used as in the case of ulcers, which will be presently alluded to.

II. WOUNDS IN WHICH FERMENTATION ALREADY EXISTS.—Wounds and sinuses which have not been treated aseptically, and in which fermentation therefore exists, often come under observation. Here an attempt may be made to destroy the causes of fermentation which already exist in these wounds, and these attempts are sometimes successful. In these cases, the micro-organisms not only exist in the discharges which flow from the wounds, but they are also present in the granulation-tissue lining them. It is therefore necessary not merely to disinfect these discharges, but also to destroy or disinfect the lining membrane of the wounds. For this purpose, the layer of granulations is scraped away by means of an instrument termed a "sharp spoon," introduced by Von Bruns for scraping away carious bone, and first used by Volkmann for the purpose under consideration. (Figs. 238, 239.) The whole procedure is

Fig. 238.



Fig. 239.



Volkmann's sharp spoons.

as follows: A spray being employed, the skin surrounding the sinus is thoroughly washed with 1-20 carbolic lotion, and then the layer of granulations lining the wound is scraped out with a sharp spoon. After this is done, the wound is thoroughly swabbed out with a watery solution of chloride of zinc (40 grs. to the ounce of water). It is well, where possible, to arrest the circulation by means of a tourniquet, so as to allow the chloride of zinc to act thoroughly. Then gauze, wet in carbolic lotion, and a carbolic gauze-dressing are applied as usual.

Where superficial ulcers have to be dealt with, it is not necessary to scrape the surface of the sore, and the spray is not employed. The surface of the sore is washed with the solution of chloride of zinc, or iodoform powder is freely sprinkled on it, and the surrounding skin is washed with 1-20 carbolic lotion. A piece of protective a little larger than the sore is then applied over it, and outside this, one or more layers of boracic lint, overlapping the protective well in all directions. The boracic lint is prepared by immersing ordinary lint in a saturated, boiling solution of boracic acid, and then hanging it up to dry. In the after-treatment, boracic lotion is employed instead of carbolic lotion. This is simply a cold, saturated solution of boracic acid in water. The lint and protective are removed, the sore is washed with the lotion, and a fresh dressing is applied. The spray is unnecessary. When the discharge diminishes, these dressings may be left unchanged for two or three days. As a rule, one application of the iodoform or chloride of zinc solution is sufficient, but if putridity still exists, they may be employed a

second time. Sores treated in this way heal very rapidly if proper attention be also paid to position and rest; they heal more rapidly than by any other method of treatment.

Various modifications of the Listerian method have been proposed, but they have seldom been satisfactory, as they have generally failed to fulfil the requirements of the aseptic principle. In the foregoing description, various modifications have been hinted at which may be followed out where better means are not at hand, and which will be efficient as long as they are used in strict accordance with the Listerian law. Other antiseptics have been suggested instead of carbolic acid, but none of them have as yet been generally adopted. Perhaps the best substitute is eucalyptus oil. This has of late been used extensively by Mr. Lister in the form of eucalyptus gauze, and it acts very well. It is of great value in those rare cases in which patients suffer from carbolic poisoning. Eucalyptus gauze may be used in these instances without interfering with the aseptic principle. I would be passing the space at my disposal were I to enter into the discussion of the various materials and modifications which have been proposed. The foregoing description indicates sufficiently the best mode as yet known of applying the principle, and it will be evident that other antiseptics and antiseptic materials may be employed, and that the use of the spray may be avoided, where necessary, without in any way interfering with Listerism, which is a principle which must in the future always form the basis of any method of wound treatment. When properly applied, it reduces all wounds to the level of subcutaneous injuries.

[CORROSIVE-SUBLIMATE DRESSING.]

The antiseptic substance which at present seems to obtain most favor is the bichloride of mercury, which enters into the "sal-alembroth" dressings now employed by Professor Lister. The exact composition of the "sal alembroth" in its modern form does not appear to have been published,¹ but a short account is appended of the dressings used at the Pennsylvania Hospital, Philadelphia, where the corrosive sublimate is largely employed, and almost to the exclusion of other antiseptic agents. Before an operation the part is shaved, and rubbed with oil of turpentine or ether, then with soap, and finally with a 1-1000 solution of the bichloride. A piece of oilcloth, wet with the solution, is laid beneath, and towels dipped in the same are placed around the part to be operated on. *Instruments* are boiled and immersed in a three per cent. solution of carbolic acid, and needles, pins, etc., are kept in a similar solution made with glycerine. *Sponges* are used but once; they are carefully cleansed and bleached, and then stored in a 1-1000 solution of corrosive sublimate. Both *ligatures* and *sutures* are made of catgut, prepared with oil of juniper and alcohol, or carbolic and chromic acids, according to the length of time which it is desired that they should hold their position. The spray is not used—and indeed very few surgeons still employ it—but the wound is frequently *irrigated* during the operation with a sublimate solution of the strength of 1-2000. *Drainage* is secured by the use of strands of catgut, or of india-rubber tubes, etc., the wound before closure being

[¹ In Milne's catalogue of antiseptic dressings it is said to consist of corrosive sublimate and sal ammoniac in combination; according to Dunglison, the "sal alembroth" of the alchemists was a product resulting from the sublimation of a mixture of these substances.]

thoroughly washed with the solution, and then closely sutured. A thin strip of Lister's "protective" is next adjusted, and the part is wrapped in a *dressing* of carbolic gauze, prepared as described on page 72, wrung out of a 1-1000 bichloride solution, and thickly dusted on its inner surface with iodoform. A pad of bichloride absorbent cotton (1-1000) is superimposed, and the whole is secured with a gauze bandage. Unless indicated by prolonged elevation of temperature, by excessive pain, or by the appearance of discharge, the dressing is not disturbed for a period varying from one to several weeks, when it is either removed, or replaced by a simple dressing of boracic-acid ointment.]

POISONED WOUNDS.

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UNDER ordinary circumstances, if a healthy person sustains a wound of the skin, whether incised, lacerated, punctured, or gunshot, the tendency is toward repair of the local damage, without any other constitutional disturbance than may be due to the severity of the injury. By the older writers this was attributed to what they called the *vis medicatrix naturæ*, or healing power of nature, an expression which was objectionable, as implying an external force. It is more philosophical to say that healthy action is the law of being of living organisms, and of all their parts; and that they tend to return to this, if disturbed by any cause, as soon as that cause ceases to act.

But if, either at the time of infliction of the wound, or at some later date, before the healing has occurred, a poison is applied to the abnormally exposed tissues, there is superadded to the violence sustained, an irritation, which may not only change the local condition, but affect more or less profoundly the whole organism. The poisons which so act, and with which we are now concerned, are almost without exception of animal origin, and some of them would seem to be actually organized. Of their real nature, however, very little is known as yet, and the mode in which they produce their effects cannot be clearly explained. We can only describe the symptoms to which they give rise, and suggest theories as to the pathological conditions involved.

There are three ways in which poison applied to a wound (either at the time of its infliction or subsequently) may be supposed to affect the system at large: (1) Through the nervous system; (2) By absorption into the lymph current; (3) By absorption into the venous blood current. Very probably these are often combined in the same case; and it may be that in no single instance does even the slightest poisoned wound occur—such, for example, as a mosquito sting—without an irritation of the nerves of the part, and the taking up of an amount, infinitesimal as it may be, of the poison, not only by the lymphatics but also by the veins. Perhaps it should be stated that the evidence as regards venous absorption is less positive than that of absorption by the lymphatics, since the cases in which the former seems to have taken place are in many instances open to another explanation, viz., that the poison was conveyed into the venous system through the lymph-channels. Thus there are many cases in which the extension of inflammation along the lines of the lymphatics is quite clear; there are none in which equally distinct proof is afforded that the veins alone are so affected. But these points will be further referred to.

Certain conditions of system seem to favor the occurrence of poisoning in wounds. Such are depression, from fatigue or exposure; previous disease;

the effects of extremes of heat or cold, and perhaps of other states of the atmosphere, electrical or hygrometric. These influences are more clearly traceable in the graver cases, but are probably not without effect even in the more trifling. And we shall have to note, on the other hand, some singular instances of tolerance, or rather of insusceptibility, induced by habit. I shall take up in succession: dissection-wounds, and certain allied lesions; insect-stings; snake-bites; and bites of animals.¹

DISSECTION-WOUNDS.

Under this head are included, not only wounds or poisonings contracted in the dissection of dead bodies, but an allied class of injuries sometimes sustained by surgeons in operating on the living, as well as under other circumstances, to be presently mentioned.

While in the very great majority of cases the poison finds an entrance through some crack, fissure, or puncture in the skin, there seems to be evidence that it may sometimes be absorbed through the sound tissues. Thus, Sir James Paget, in his most interesting account of his own case, says, "I had no wound or crack of any kind."² Wiart,³ after describing a poisoning in his own person in 1862, from making an autopsy in a case of erysipelas, says, "I have always been convinced that I had not been wounded at all, that I had, neither on my fingers nor on my hand, any erosion to serve as a place of entry for the virus."⁴ But even when there is no actual wound, if the cuticle is so cracked, as for instance, along the edge of the nail, as to give the poison access to the true skin, it may be taken up by the absorbents and produce mischief.

However the harmful material enters, there must be, as it seems from known facts, a certain condition of the system (perhaps various conditions) rendering it susceptible to injury. Those who are constantly dissecting may acquire, as Sir James Paget points out in the paper referred to, a marked degree of immunity, so that no bad consequences ensue upon the cuts and scratches which they are very apt to sustain. Yet this cannot be counted on, and those who are depressed by fatigue or other causes, as students often are after a winter's work, may be specially liable to this form of disorder. The period which elapses between the reception of the poison and the occurrence of trouble from it may vary greatly; sometimes inflammation is set up at once, or in the course of a few hours, while it occasionally seems as if there were a process of incubation, as in hydrophobia or in the eruptive diseases. Cases are upon record in which no symptoms have ensued for several days; but here there may have been some new influence affecting the system, without which the poison would have remained inactive.

In former times, before it was the practice to use antiseptic injections, such

¹ It may be said here, that while it might be strictly proper to include tetanus, hydrophobia, and pyæmia in the present subject, there is in each of these diseases so new and formidable a chain of symptoms developed, in comparison with which the original wound ceases to have any importance, that they are generally accorded separate consideration.

² Clinical Lectures and Essays, p. 322.

³ Gazette Médicale, July 23, 1881.

⁴ In the American Journal of the Medical Sciences, for August, 1838, p. 396, there is an account of a typical case of diffuse cellular inflammation, ascribed by the reporter, Dr. J. M. B. Harden, of Georgia, to the violent motion of the arm during a long ride on horseback. The case was a fatal one, and at the autopsy Dr. H. contracted blood-poisoning through an existing wound in the finger. During his illness he was attended upon by his father-in-law, who dressed the abscesses, introduced tents, etc. This gentleman became ill after sudden and great exertion in putting out a fire, diffuse cellular inflammation manifesting itself, and terminating fatally. No wound is mentioned in his case, but only contact with pus. Another slighter case is said to have occurred in the person of another attendant upon Dr. H. during his sickness.

as chloride of zinc solution, in preparing bodies for the dissecting-room, dissection-wounds, or serious symptoms following upon them, were much more common than now. The danger is incurred in dealing with the tissues of the recently dead rather than with those in a state of advanced putrefaction, and it is well known that post-mortem examinations of those who have died of certain diseases—especially of puerperal fever, erysipelas, or pyæmia—are attended with peculiar hazard. It would seem as if the earliest changes undergone after the occurrence of death were those which developed the poison. Very possibly the *ptomaines*, or cadaveric alkaloids, substances allied to the vegetable alkaloids, recently studied by Brouardel and Boutmy, Selmi, and other European observers, may be found to play an important part in the causation of the mischief. With regard to these substances very little is as yet known, but it is stated¹ that they are supposed to be analogous to a constant ingredient of saliva, which, in a concentrated form, is the active constituent of the venom of snakes. M. Brouardel is quoted in the same connection as of opinion that the *ptomaines* may be formed during life. One point should be especially noted, viz., that the amount of poison absorbed in a case of dissection-wound (using this term in its general sense) makes no difference in the effect. The minutest portion seems to act as a ferment, and to change the condition of the whole mass of circulating blood. In this respect, the analogy between the dissection-poison and snake-venom seems to fail, since the effect of the latter is clearly proportionate to the amount and concentration of the dose received into the system, as in the case of mineral or vegetable substances taken by the stomach or rectum.

SYMPTOMS OF DISSECTION-WOUNDS.—In the slightest form, the effects of this species of poison seem to be purely local. Thus if the dissector has a prick or scratch on his hand, it may become the seat of slight inflammation, and in a day or two discharge a small quantity (perhaps only a drop or two) of pus. But the cuticle around generally dies and peels off, just as in the case of a boil, and the redness and swelling disappear somewhat slowly.

Sometimes, especially after the fingers have been for some time in contact with purulent liquids, and more particularly in abdominal abscesses, the poison may affect a chain of points on the backs of the hands. Thus in 1862, after making a post-mortem examination in a case of peritoneal inflammation, with suppuration, from an intestinal concretion in the vermiform appendix, I had four or five small abscesses on the back of each hand. In these cases, there seems to be no further action of the poison, although the local conditions are analogous to those present when inflammation extends upward along the course of the lymphatics. Occasionally there occurs enlargement of the lymphatic glands in the axilla, either without any notable lesion of the hand, or, if such should exist, without any traceable affection of the vessels. This, I think, is not apt to be from the ordinary dissection-poison, but may be met with where injected bodies are used for purposes of study; it seems to be from the irritant effect of the chloride of zinc or other chemical antiseptic employed. The swelling of the glands is chronic in its character, not painful, nor very tender, and has not in my experience run into suppuration, but has gradually subsided, under the local use of tincture of iodine. Agnew describes² a peculiar form of irritable sloughing ulcer of the hand, attended with marked constitutional disturbance, as a result of dissection-wounds. This I have never seen, although it has sometimes happened to me to note the very slow healing of severe cuts received in making autopsies; one in my own person,

¹ Gaz. Méd. de Paris, July 30, 1881.

² Principles and Practice of Surgery, vol. i. p. 210.

in 1860, remained open for seven months. Bryant,¹ under the name of *Veruca necrogenica*, proposed by Dr. Wilks, mentions a warty condition occasionally seen on the posterior aspect of the fingers, or on the knuckles, in those engaged in dissecting fresh bodies. This lesion, called also "anatomical tubercle," seems to consist of an inflammatory hypertrophy of the cuticle, and to some extent of the true derm. It is slow and obstinate in its course, unattended with any constitutional symptoms, and yields to local treatment by iodine and caustics.

In a severer grade of dissection-wounds, there is, in addition to the local irritation, a line of redness (sometimes several), extending up the forearm, and marking the course of one or more inflamed lymphatics. There may also be more or less general swelling of the member, with tenderness and stiffness, and some degree of fever. A not infrequent termination of a case of this kind is by swelling of a lymphatic gland, either on the front of the forearm, just above the elbow, or in the axilla. When suppuration of the gland takes place, the poison seems to be discharged, and all the symptoms subside; but I have seen such a gland remain swollen and tender for some time after its healing had seemed complete. The condition just referred to is very similar to what may be observed in many cases of injury to the foot, even in the apparently robust. It not very unfrequently happens after the fracture of a toe, or even a slighter hurt, in laboring men, that a "bubo" is formed in the upper part of the thigh; and the same may occur in healthy and well-nourished children, even in the better classes.

Still another class of cases may be mentioned, in which the local trouble consists in the development of a carbuncular swelling somewhere on the hand or forearm, or in a crop of boils in the same region; in the latter case there is apt to be one large one surrounded by a number of small ones. The constitutional symptoms, with fever and depression, may be quite marked during the height of the local irritation.

Sometimes the local disturbance is more violent, and a cellulitis of the finger ensues, with suppuration, tending to follow up the sheaths of the tendons; this may occur without involvement of more central parts, but the constitutional symptoms are apt to be marked. In the majority of instances, the whole limb is more or less concerned, and the cases would then come under the class next to be described. With any of these forms of dissection-wound, except the anatomical tubercle, there is very apt to be a more or less extensive area of erythematous redness in the neighborhood of the lesion.

In the severest grade of these cases, the constitutional symptoms are very decided, and the local inflammation runs very high, extending rapidly toward the more central parts of the body. At a variable period after the poison has been received, there is pain, itching, and burning at the spot, and a general sense of malaise and depression. This is soon succeeded by headache, nausea, chilliness, and aching in the back and limbs. The pain runs up the arm, and the whole member becomes swollen and tender, especially along the anterior and inner aspects. Intense fever comes on, especially at night, and the patient is either sleepless, or disturbed by frightful or harassing dreams. On the occurrence of suppuration, which may involve a large extent of the areolar tissue of the arm or side,² there are general rigors, and a further increase of fever. Low muttering delirium is early developed, with great

¹ Manual for the Practice of Surgery, 3d Am. ed., p. 66.

² At a recent meeting of the Clinical Society of London (Lancet, Feb. 19, 1881), Messrs. Heath and Cripps reported cases of gangrene of the arm from poisoned wounds. In Mr. Heath's case amputation was successfully performed; but in the other it was postponed until too late, and the patient died. Sloughing of the cellular tissue, as already said, is very generally resented in these cases; but gangrene of the limb is very rare.

prostration of strength, and profuse and fetid sweating. The tongue, at first coated with a dirty fur, becomes dry and brown, and the teeth are covered with sordes. During the accessions of fever, the temperature runs very high, and the pulse is extremely rapid. Sometimes the patient seems to succumb to the general systemic poisoning before there is time for definite lesions of internal organs to occur; but if the progress is less hurried, there may be a supervention of pleurisy or pneumonia of a low type, readily running into suppuration. Death may result either from prostration by the poison; or from deterioration in the quality of the blood, affecting the brain-functions; or from intercurrent inflammation of the lungs or pleura, or perhaps of the heart; or from secondary exhaustion. When recovery takes place, it is very slow, and resembles that from typhoid or other low fevers, being apt to be retarded by abscesses and other local disorders. Moreover, there is often stiffening and contraction of the finger which was the seat of the primary inflammation. For a time there may be also, when sloughing has been extensive, some impairment of motion in the parts concerned; but this is gradually done away with by time and the stretching incident to exercise.

From this brief sketch, it may be seen that the graver cases of this sort can scarcely be excelled in severity by those of any other known disease. And the analogy which they present to cases of phlegmonous erysipelas, as well as of pyæmia and septicæmia, is obvious. At the present day, the recognition of the fact that the condition is one requiring, not depletion, but the most active and energetic supporting measures, has led to a more judicious treatment, and it is only in extremely rare cases that the symptoms are not arrested before they assume the threatening character above described. But still, whether from previously-existing disease, as, for example, of the kidneys, or from fatigue or exposure, at the time or subsequently, the onset of the disorder is occasionally very violent, and the most prompt, energetic, and skilful interference may be of little avail.

For obvious reasons, the post-mortem investigation of disease of this kind is both difficult and dangerous; and we have but little knowledge of its pathology. The tissues of the limb affected are apt to be disorganized by diffuse suppuration, veins and lymphatics being alike involved, while the internal organs present inflammations of varying extent and intensity; but the sequence of the morbid conditions, even in the light of the most careful observation during life, cannot be unravelled. That the lymphatic system plays an important part seems unquestionable.

Allusion has already been made to the occurrence of poisoning of this kind from other causes than dissections. Thus surgeons sometimes sustain injury by scratching or pricking their fingers in the performance of operations, and symptoms analogous to those already described may ensue. Perhaps the most frequent source of injury of this kind is contact with rough points or edges of dead bone, as well as with pus, especially of an unhealthy or foul character. Carelessness in cleaning and handling instruments may also give rise to poisoned wounds. But in all these cases, the matters which act as poisons are practically dead.

I saw, in 1865, a child aged 22 months, who had been vaccinated by a woman living in the neighborhood, and who had diffuse suppuration, with sloughing of the areolar tissue, from beneath the scapula to the crista ili. Death ensued in a day or two, and an autopsy was made; but the disorganization was so great that the exact sequence of lesions could not be determined. I believe, however, that this case was one of blood-poisoning by the use of a dirty lancet.

Another case of blood-poisoning by vaccination came under my notice in 1869, in which the disease assumed the form of erythema fugax. The vaccination had been per-

formed by a most careful physician, of high standing, and the child's parents were people of the best class; so that it was difficult to account for the origin of the poison, which proved fatal.

It will be sufficient merely to mention here the liability of surgeons to syphilitic infection, from absorption of the discharge from sores of that character, in the course of their professional duties. Fortunately this is rare.

It has been stated on a previous page that poisoning is more apt to occur from bodies recently dead (that is, in which the post-mortem changes are in their early stage), than in those which are already putrid. Yet animal substances in the latter state may be productive of injury in the same way. Thus Heath¹ speaks of the digital cellulitis known as whitlow, as sometimes caused in cooks and others by the handling of game which is "high." And a notice recently appeared² of the poisoning of the Medical Officer for Health for Rotherhithe, near London, by a wound of the hand received in making a microscopic examination of some pork. It is said that "the meat was so putrid that he was compelled to use disinfectants, which obscured the minute structures; but he satisfied himself that the animals had been the subjects of, if they had not died of, pig-typhus; and he believes also that they were trichinised." The report goes on to say that he had "narrowly escaped permanent maiming."

TREATMENT OF DISSECTION-WOUNDS.—The treatment of all these cases must be: to subdue the local inflammations, and to support the strength.

Wherever there is heat and swelling, with pain, either at the part injured or at points nearer the body, hot fomentations, hot poultices, hot lead-water and laudanum, and like dressings, will be found to give comfort. It should be mentioned that any wound received, or any puncture or cut becoming irritated, during a dissection or operation, ought to be at once washed clean, thoroughly sucked, and protected. I have myself great faith in thorough cauterization with nitrate of silver, or with a white-hot needle, *if done at once*. The best protective application afterwards is a strip of clean rag or lint thickly spread with any simple unguent, as cosmoline, carbolized cerate, or mutton-tallow. A clean cut may be closed with a strip of plaster, which should however be at once removed if pain or swelling come on.

As soon as suppuration occurs, the part should be freely laid open, and poultices applied. Should the inflammation extend up the arm, it has been recommended to place a *cordon sanitaire* around the member, by painting it with tincture of iodine or with a very strong solution of nitrate of silver. Either of these may be used, a band about an inch wide, encircling the limb, being applied above the higher limit of the area of inflammation. This sometimes seems to be of benefit in arresting the disorder, just as in erysipelas; but it cannot be relied on. Blistering has been used in the same way, and is recommended by Agnew.³

Tonics, such as iron, quinine, the mineral acids, and concentrated food, should be given from the very first; in as large doses as the stomach will bear. Carbonate of ammonium is a valuable adjunct in combating prostration. Stimulants are often imperatively called for, given either separately or along with the food. Dry champagne is well borne, and has the advantage of allaying the gastric irritability which is often a marked feature of these cases. When the fever runs very high, the ordinary febrifuges may be employed, and sponging with hot whiskey or bay rum and water. Anodynes

¹ Medical Times and Gazette, June 18, 1881.

² Ibid., Aug. 31, 1881.

³ Op. cit., vol. i. p. 212.

are sometimes demanded by the severity of the pain, and must be given. Opiates need not be withheld unless there is a strong tendency to cerebral congestion; they may be combined with the quinine, and the iron given separately. The bromides and chloral-hydrate, in mild cases, answer a good purpose; but the stomach may not always bear them well.

By way of *prophylaxis*, some dissectors are in the habit of smearing the hands, previous to beginning an autopsy, with cerate, either plain or carbolized; others use caoutchouc gloves or finger-stalls. But in neither case is the protection at all perfect. The cerates are soon removed by contact with the tissues, and the thin sheet of rubber is readily penetrated by a knife-point, a tenaculum, or a spiculum of bone.

OTHER FORMS OF INJURY ANALOGOUS TO DISSECTION-WOUNDS.

There are certain other cases which may be most appropriately mentioned here, as they are closely analogous to those just spoken of.

FISH-WOUNDS.—Some *fishes* have sharp fins or spines, which inflict severe and “poisonous” wounds. An instance in point is reported by Murray:—¹

A young man on the Irish coast was wounded by a fish called a “stang,” a sort of herring, with hard scales and a sharp dorsal fin, well known to fishermen on account of the danger of its sting. The wound was in the ball of the thumb; the man sucked it, but he had pain up the arm as far as the axilla, and next day the whole limb was swollen, a bubo had formed in the armpit, and there was marked fever and headache. Pulse 98, temp. 100.5°. An incision was made, laying the wound open; poultices, and subsequently dry cotton, were used, and the arm was dusted over with dry bicarbonate of sodium. A purge was also given. The man made a rapid recovery.

In the Mediterranean, and in some Eastern seas, there are other fish which have dorsal spines capable of poisoning the wounds inflicted by them. Some again have the poison-spines connected with the gill-covers. One species is mentioned by Nielly,² as found at Panama, having four spines, two dorsal, and one attached to each gill-cover; each of these spines is said to be traversed by a canal leading to a sac full of liquid venom. The *Acanthurus*, met with in the waters about the Antilles, has its spines, which are mobile, on either side of the tail. The *skate*, or *ray*, is often called “sting-ray” or “stingaree,” from its long, sharp, caudal spine, wounds from which are troublesome but not dangerous. Bathers along the Atlantic coast are often stung by the jelly-fish, or *Acalephæ*, found in the water especially after storms; the injury seems to be due to an irritating secretion ejected through the tentacles, and induces symptoms resembling those of urticaria, with occasionally a decidedly erythematous tendency.

OYSTER-SHELLS sometimes seem to have a poisonous effect, producing great irritation if the hands are scratched with them; in this respect they resemble the sequestra of dead bone, before mentioned.

ANIMAL TYPHUS.—I am tempted to refer here to a case reported by Pichon, and quoted by Dr. Jamieson, of Shanghai, China.³ It was that of M. Charrier, a veterinary surgeon, who was examining a cow suffering from typhus, when the animal coughed up a quantity of foul discharge, part of which

¹ Lancet, Jan. 3, 1880.

² Éléments de Pathologie Exotique. Paris, 1881.

³ Medical Times and Gazette, July 23, 1881.

entered his mouth. He became very ill, with such local symptoms—diphtheritic stomatitis, with a strong gangrenous tendency—as seemed very like those of a poisoned wound. From the chronic septic poisoning which ensued, death resulted in about six months.

POISONOUS EFFLUVIA.—One other form of poisoning by animal secretions ought not to be passed over—that by *inhalation of effluvia*. The reader will find this fully discussed in a most interesting paper by Dr. William Hunt.¹ Except in the mode of its origin, and in the absence of primary local symptoms, it does not differ materially from the disorder already described.

Mr. H. E. Cauty² reports a case of poisoning of a sewing-woman from handling "*Imitation Moleskin*." He says that, although there does not seem to be anything peculiar in the material, the women employed have to be very careful, as nasty sores are sure to be produced if they have any fissures or abrasions on the hands. This woman had on her hands nodules (seven on the right, five on the left) about the size of marbles, bright red, and very painful. These nodules suppurated in about a week; on the left hand there was some burrowing of pus, and on the 12th day some sloughing took place. Thirteen days after she was seen, two more nodules formed on the right hand; red lines extended up the forearm, there was glandular irritation at the elbow, and tenderness in the axilla. The skin exfoliated over the affected parts. Complete recovery ensued under the use of wine, cod-liver oil, and full diet.

WOOL-SORTER'S DISEASE.—Within the last year or two, attention has been called anew to a disorder known as "wool-sorter's disease," or "anthrax-fever." It seems to be analogous to the forms of toxæmia described in the foregoing pages, and perhaps to be a sort of connecting link between them and "malignant pustule." The following description of it is condensed from various articles in recent English journals, it having prevailed so extensively in and about the manufacturing town of Bradford, as to call for investigation and report.

The wool and hair of sheep and goats, imported for various purposes, was found to produce unequivocal attacks of anthrax, or "murrain," in sheep and cattle. Upon the persons employed in sorting and cleaning it, it produced effects classified as follows: (1) A purely local irritation at the seat of inoculation; (2) constitutional symptoms; (3) local manifestations followed by secondary localization of a constitutional infection; (4) a papule or pustule, not hitherto ascribed to specific infection, but not uncommon among wool-sorters, and those who make post-mortems in cases of anthrax. The stage of incubation is said to last from a few days to long periods. In the prodromal stage, there are chilliness, weariness and depression, sweats, flushing, and sleeplessness; a sense of constriction of the chest, sighing, yawning, aching in the limbs, cramps, headache, pain in the neck, dizziness, nausea, and vomiting. In the stage of full development, there are prostration, restlessness, quickened respiration and pulse, high temperature, *with irregular remissions*, pulmonary congestion, hæmoptysis, gastro-intestinal distress, diarrhœa, and jaundice in some cases. Twice tetanus was developed; once cerebral hemorrhage occurred. Recovery sometimes took place, without immunity from a second attack.

The pathological anatomy of the disease is thus described.³ Early decom-

¹ A Contribution to the History of Toxæmia. Pennsylvania Hospital Reports, 1868, p. 310.

² Lancet, July 23, 1881.

³ J. Spear, Report to Local Government Board, etc.

position; petechiæ. *Heart* flabby, hemorrhages in its walls; endocardium blood-stained; often pericardial effusion; blood fluid. *Lungs* hyperæmic; small scattered hemorrhages in them; œdema, true pneumonia, or metastatic abscesses, or sometimes hemorrhagic infarcts. (The smaller hemorrhages were due to emboli formed of bacilli, the larger to acute nutrient disturbances of walls of bloodvessels or tissues.) *Bronchial glands* swollen, soft, or purple and blackish; *bronchial mucous membrane* reddened, with hemorrhagic extravasations; *pharynx* and *trachea* hyperæmic. *Abdominal organs* congested, with various hemorrhages. *Spleen* large and soft; *kidneys* congested, and the seat of cloudy swelling. Often acute *intestinal catarrh*, and swollen *mesenteric glands*. Sometimes albuminuric hemorrhages in the *brain*. Serous or serous and bloody, jelly-like infiltrations in the *connective tissues*, especially in the neck and mediastinum, in the sub-pleural and peri-renal tissue. Bacilli were usually detected in the blood and extra-vascular fluids. A curious fact was noticed—that this disease was apt to be developed by the eating of vegetable food, and thus to occur after the Sunday indulgence in this diet, usual with the wool-sorters.

INSECT-STINGS.

Very few insects can properly be said to bite, as they have not the apparatus for so doing; they insert a terebra or aculeus, and then suck, by means of a haustellum or sucker. In this act, they inject at the same time an irritating secretion of a peculiar kind for each species, but always acid. Most of them, in inflicting the injuries they do upon man, are simply obtaining nourishment, not attacking him; but there are some, as the bees and wasps, which are provided with poison-glands and stings as weapons of offence and defence. Of some varieties, as for example the mosquito, it is the female only that stings; the males do not leave their breeding places.

There are such differences between the effects of the stings of various insects, as would seem to indicate the possession of a specific character by each. Thus the *bedbug* causes a white wheal, surrounded by an area of redness, with intense burning itching, which, however, very soon disappears, and finally. When the bug is a very small young one, the wheals produced by it are correspondingly small, although they may itch intensely. Usually there are a number of punctures near together, marking the course of the insect as it crawls over the skin, each one being the centre of a separate wheal. For a few hours, the irritation may be re-developed by scratching. When in the eyelids, the swelling that ensues may be so great as to temporarily close them.

The *mosquito* induces a red swelling, somewhat conical, persistent, the irritation of which recurs occasionally, with or without apparent cause, for days. There is a different variety of mosquito, which comes with the first warm days of spring, and gives rise to a wheal like that from the bedbug, afterwards assuming the characters of the ordinary mosquito-bite.

Two cases of severe mosquito-bite are thought worthy of special record by Mr. G. Thin.¹ A medical man is said to have been "so cruelly bitten on the face and head, that he was much disfigured." In the case of a young lady, residing in the same hotel, "the bites were chiefly on the nose and upper parts of the cheek, and were seen as large, raised, flattened vesicles—not unlike a vaccine pustule, with a central depressed dark point, which corresponded to the point bitten. These vesicles had been confluent over the nose, and produced an appearance of impetiginous eczema, with well

¹ Lancet, Aug. 27, 1881.

defined borders. The discharge had, on some parts of the cheeks and chin, which had not been bitten, produced, secondarily, bullæ of what is often called *impetigo contagiosa*."

The sting of the *flea* produces a larger, very red and angry, flattened, long ovoidal swelling, or welt, with a peculiar velvety feel; it is very persistent.

The *louse* simply inserts its sucker into a follicle of the skin in search of nourishment, and the rupture of one or more small vessels is apt to occur. The ensuing inflammation is due more to the scratching than to the intensity of the poison.

Certain *nidges* are sometimes met with in swarms at the seashore, and are very annoying by the sharp but very transient irritation caused by their suckers.

Among *flies*, the large "green-head," found on the Jersey coast in the late summer, and the "black fly" of June, in the northern woods, may, perhaps, be considered as the most troublesome species. The former produces a very severe irritation if allowed to penetrate the skin, as it often does in children.

Some of the *Ixodes* or *ticks* are very poisonous to man. There is a very small variety met with in dry, sandy woods in New Jersey, and perhaps elsewhere, which buries itself in the skin. I have known of two or three instances of children being nearly covered with them, especially in the legs and about the scrotum; the itching induced was intolerable, especially at night, totally preventing sleep. But in tropical climates, and occasionally in this latitude, the larger species are sometimes encountered. I saw a gentleman in 1881, who had had the horny head of a large *Ixodes* buried in the skin of his chest for several years, occasionally to his great annoyance.

Mr. R. R. Allen writes, from Natal, S. Africa, to the *Lancet*, Aug. 27, 1881, an account of the *Ixodes reticulatus*, or ox-tick, which buries its sucker in the skin, and when filled with blood, is half an inch long. He says: "On June 28th, I was bitten by one of these little animals in the right axilla. When caught, it was deeply buried in the flesh and 'full-blown.' I had to use force to extract it. The next, and four following days, I was very unwell, with severe frontal headache, which continued for three days, nervous depression, loss of appetite, thirst, pain, swelling, and stiffness of the muscles of my right arm and axilla. The axillary glands became hard, enlarged, and most painful, but did not suppurate. The punctures made by the tick became a pustule with a dark inflamed areola, which burst and dried up. The feverishness was considerable, and I suffered greatly from nausea, insomnia, and towards the end diarrhoea. I am now convalescent (July 4). Perhaps I got the tick from my horse, which was suffering from mange at the time."

The *scorpion* is very seldom met with, except in tropical countries, and there its sting, although very irritating, is seldom fatal. Swelling of the tongue is said by some writers to be a constant symptom in these cases, and sometimes a singular loss of power in the cervical muscles has been observed, as if the poison, when absorbed, acted in a special degree upon certain portions of the nerve-centres.

Spiders have a bad reputation, but the cases are certainly very rare in which dangerous injury is inflicted by any of the species known to us. Yet Stahl¹ reported a case in which the sting of a "black spider" on the elbow produced a condition of alarming collapse; and Hulse,² one in which like symptoms followed a hurt of the same kind on the penis. (In both these cases the old-fashioned antiphlogistic system, including copious venesection, calomel, and tartar emetic, with active purgation, was adopted. Hulse states that his patient took, within four hours, four ounces of laudanum and an equal quantity of aqua ammoniæ.)

¹ American Journal of the Medical Sciences, Aug. 1838.

² Ibid., May, 1839.

Centipedes (*Scolopendridæ*) can bite or nip with their mandibles, and some inflammation is apt to follow; a fatal case of this kind, in a child, has been reported by Dr. Linceicum, of Texas.¹ In this case the little irritated holes made in the skin by the feet of the insect were also noted, and any one who has happened to touch one of our common centipedes will be likely to have felt a peculiar slight thrill in the fingers, lasting for some time. But the amount of poison contained in these small animals is of course vastly less than in one such as Dr. L. describes—eight inches long and nearly an inch broad. Nielly² quotes from Moquin-Tandon an account of an officer at Cayenne, in 1828, who by accident swallowed a centipede in some water. Enormous swelling of the neck, profound nervous symptoms, and death, speedily ensued.

Attention may here be again called to the fact that in these poisonings by insects (and the same is true in the case of snake-bite, to be presently discussed) the quantity of venom taken into the system determines the severity of the symptoms induced. In this respect the disorder, for it seems to be one and the same, no matter what the source is, differs from that induced by dissection-wounds, in which the smallest dose of the morbid agent may develop the gravest possible constitutional condition. It is but rarely that any serious general disturbance follows upon insect-stings, although, when in large numbers, they may produce feverishness and languor. Travellers who are subjected to the attacks of bugs and fleas sometimes experience this, but the loss of sleep may have something to do with it. And cases are upon record in which death has resulted from bee-stings and other injuries of this kind.

In some of these instances men, and even horses or other animals, have been attacked by swarms of bees, wasps, or hornets, and have sustained so much injury as to destroy life almost at once. No very careful investigation of these cases has ever been made, and the circumstances have generally been such that even a skilled scientific observer would have found it difficult to note the phenomena accurately; but it would seem that so large a dose of insect-poison acted very much like snake-venom, and that the main cause of death was the shock to the nervous system. Of fatal results following single stings, Dr. James Mease³ has recorded a number of instances, and refers to others. Dr. J. A. Lidell,⁴ in an article on Injuries of the Scalp, refers to poisoned wounds of this region as especially dangerous, and gives accounts of and references to several cases of the kind now under consideration. Dr. A. L. Gihon, U. S. N., reports⁵ a case of fatal poisoning occurring on board ship, at Nagasaki, Japan, by the sting of an unknown insect; the part attacked was a middle finger; and the symptoms resembled those of sedative narcotic poison. Four days elapsed in this instance between the onset of the disorder and its fatal termination; an unusually long period.

TREATMENT.—The treatment of all these cases is, in its general principles, the same; local irritation is to be soothed, and if constitutional symptoms occur, they are to be combated by appropriate remedies. Alkalies, as dilute aqua ammoniæ or solution of carbonate or bicarbonate of sodium, seem to neutralize the poison. Every boy knows the comfort given by a clay poultice to a bee- or wasp-sting. Ordinary poultices, or lead-water and laudanum, may be applied if there is much inflammation.

¹ American Journal of the Medical Sciences, Oct. 1866.

² American Journal of the Medical Sciences, Nov. 1836, p. 265.

³ Ibid., April, 1879, p. 336.

⁴ Op. cit.

⁵ Ibid., April, 1869.

SNAKE-BITES.

As is well known, there are many genera of snakes which are destitute of poison-apparatus, and wholly harmless to man. Life may indeed be destroyed by the boas or pythons, the constricting snakes, which enfold and crush animals, and occasionally human beings, before swallowing them as food. But it is with venomous snakes, strictly speaking, that we are now concerned. All kinds of reptiles are much more numerous in hot than in cold climates, and in hot weather they are more active, and the danger from those which are venomous is greater.

The principal poison-snake of North America is the rattlesnake, or *Crotalus horridus*; there is also the moccasin, the copperhead, or *Trigonocephalus*, the cotton-mouth (perhaps only a variety of the last-named), and a species of *Elaps*, of which the popular name is, I believe, the "harlequin." In India, the *Cobra*, the *Naia* or *Naja*, the *Daboia*, and the *Trimerisurus*, are, according to Fayrer,¹ those which are most frequently met with, and most hurtful to man. Among African snakes, the *Cerastes cornutus*, or horned snake, and the *Naja haje*, or asp, seem to be the best known. The *Jararaca*, a Crotaline species, is the chief pest of this kind found in Brazil and Central America. The only snake known in Europe is the viper. All these are land snakes, although they swim freely on occasion. Fayrer² describes and figures a large number of *Hydrophidæ* or sea snakes, which are very poisonous; they are found in the Indian and Pacific Oceans, and in the seas between Southern China and Australia. All fresh-water snakes are harmless, except perhaps the cotton-mouth.

It would be a waste of time to quote descriptions of these serpents, further than to say that the hooded snakes are peculiar to India, and the rattlesnake to America, one only among Indian snakes, the *Ilalys Himalayana*, belonging to the Crotaline or rattlesnake group; in it the rattle is represented by a caudal spine. The poison apparatus of snakes may, however, be briefly referred to.

POISON-APPARATUS.—All venomous snakes have at either side of the anterior part of the upper jaw, two long recurved fangs, movable³ by means of a joint between the maxillary bone and the ecto-pterygoid. The poison is secreted in sacs lying behind and below the eyes; from each sac it is conveyed by a duct to a tube or canal in the corresponding fang, terminating at or near the tip of the latter. Thus the same action strikes the fang into the victim and injects the poison into the wound as it is made. Behind each fang lie others partly developed, ready to grow into its place should it be broken or extracted.

This apparatus, as well as the poison itself and its mode of action, has been, in the case of the rattlesnake, carefully studied and admirably described by Dr. S. W. Mitchell.⁴ It appears to present itself with but slight modifications in all the venomous snakes. The fang is said by Holbrook to be, in the *Elaps* of our southern States, permanently erect, and not jointed as above described.

¹ The *Thanatophidia* of India. London, 1872.

² Op cit.

³ Fayrer (op. cit.) says that in the *Hydrophidæ* the fangs are small, and differ very little from the other maxillary teeth. They have also only a groove, and not a tube, for the transmission of their poison.

⁴ Researches upon the Venom of the Rattlesnake: with an Investigation of the Anatomy and Physiology of the Organs concerned. Smithsonian Contributions to Knowledge, 1860. See also a paper by the same author, "On the Treatment of Rattlesnake Bites," etc. North American Medico-Chirurgical Review, March, 1861.

The *venom* is a glutinous, albuminoid liquid, varying in color, but generally yellowish or greenish, acid in reaction, without taste or smell. Neither heat nor cold, acids nor alkalies, long keeping, nor even decomposition, would seem to affect its activity as a poison. When taken into the stomach, it is wholly harmless, as indeed it is everywhere except in the circulating blood. It has been said to be hurtful to vegetable life; but this is disproved by experiments. This description of the rattlesnake poison, given by Mitchell, corresponds remarkably with Fayrer's account of the venom of the Cobra. No thorough chemical analysis of this substance has ever been made, although Dumas¹ is said to have found the composition of the Cobra venom to be analogous to that of yeast. At a recent meeting of the *Académie de Médecine*, in Paris, M. A. Gautier detailed some experiments upon poisons, and said that one curious result he had arrived at was "that poisons owed their deleterious action to the presence of a neutral and not albuminoid substance, and to that of another alkaloid substance, comparable to the cadaveric alkaloids—the ptomaines—concerning which there has been of late so much discussion, and which exist in variable proportions in the saliva of all animals; in birds, for example, this alkaloid is found in a state of dilution seven or eight thousand times more marked than in the poison of snakes."² These statements cannot be accepted without further inquiry, but they deserve consideration, and may lead to a more fruitful study of the subject.

MORTALITY FROM SNAKE-BITES.—Snake-bites are generally very much dreaded, and the popular opinion is that they are almost inevitably fatal. Fayrer says that, in India, the number of deaths per annum from this cause is "perfectly appalling." It would appear from the official returns,³ that 10,064 persons were said to have thus lost their lives in Bengal, in 1880; but some doubt is thrown on this estimate by the statement that an immense proportion of these cases were really suicides, falsely reported as snake-bites by their friends, "to save the honor of their families." Mitchell, in the paper before referred to,⁴ shows very clearly how it is that many rattlesnake-bites fail of fatal effect, and deduces from an analysis of cases, that recovery occurs in at least seven-eighths of the whole number. Perhaps the greater abundance and activity of the snakes in India, as well as the swarming population, their habits of life and dress, and their inferior powers of resistance, may account for the fatality of these injuries in that country. It is probable that the poison-apparatus is used by snakes against man in self-defence only, as when they are trodden upon or irritated, or startled by a sudden approach.

SYMPTOMS OF SNAKE-BITES.—As to the effects of the venom, it has been said, on a previous page, that the dose—the amount received into the system—has much to do with their severity. It is probable, also, that if the poison is discharged into the subcutaneous areolar tissue only, it may induce only local irritation;⁵ while if it enters a vein, and thus goes directly into the circulation, the results are much more serious. The part bitten immediately swells and becomes intensely painful, both swelling and pain extending up toward the body. Along with this there is intense congestion, and ecchy-

¹ Philadelphia Medical and Surgical Reporter, 1873, p. 216.

² Gazette Médicale de Paris, Juillet 30, 1881.

³ British Medical Journal, Nov. 12, 1881.

⁴ North American Medico-Chirurgical Review, March, 1861.

⁵ As in many other forms of poisoning, the symptoms are sometimes anomalous; for instance, a case is reported (Lancet, July 9, 1881, p. 75) by an East Indian surgeon, whose name is not given, in which, two hours after the receipt of a snake-bite in the right foot, pain extended up to the groin; next day it reached the right axilla, and the left forearm and elbow were painful and greatly swollen. Under the use of hot fomentations the man was well in a few days.

motie spots appear. Very marked symptoms of shock are soon manifested; fainting, giddiness, vertigo, loss of speech,¹ dimness of sight, with clammy sweats and great terror; nausea, vomiting, intense weakness; rapid, feeble pulse and labored respiration. Death may occur in a very short time—less than half an hour in one case on record, forty minutes in another²—but oftener in the course of from five to forty-eight hours. When the struggle is prolonged beyond this period, the symptoms just spoken of give way to those of the more ordinary forms of septic poisoning or septicæmia, and death takes place by exhaustion or failure of nerve-power. In these cases, it would seem that the venom, unlike the other animal poisons before considered, gained access to the system through the veins, and not by way of the lymphatics, since the latter do not show any sign of special involvement; and the rapid onset of general symptoms would indicate that the whole mass of the blood was affected at once.

But, as has been before said, in many instances the threatening symptoms either do not come on at all, or subside in the course of a few hours, sometimes even without active treatment, at least of a scientific kind. Such is the case almost always in viper-bites; thus an account is given³ of a gentleman, M. Dumeril, being bitten five times in the arms and hands by a very large viper; he fainted twice, and was very ill for twenty-four hours, but recovered perfectly. Dr. T. S. Savage relates⁴ two cases of the bite of the *Cerastes cornutus* (or *nasicornis*), a snake very much dreaded by the natives of South Africa, neither of which was fatal. And, from inertness of the venom, the small amount injected, or the failure of one or both fangs to penetrate the skin, even the rattlesnake-bite is often sustained without causing death. Hence, as Mitchell⁵ points out, remedies are often vaunted which really have but little to do with the patient's recovery.

In some instances, as in one of viper-bite reported from Cyprus,⁶ the symptoms induced by snake-venom strongly resemble those of phlegmonous erysipelas from more ordinary causes.

PATHOLOGY AND MORBID ANATOMY.—As to the pathology of snake-poisoning, we have not many positive facts. One thing seems to be well established, viz., that the venom acts as a septic ferment upon the blood, breaking down its coagulating power, and disintegrating the red corpuscles. Whether the effect of the poison on the nerve-centres is direct, as Fäyrer asserts,⁷ or whether it is a secondary result of the vitiation of the blood circulating through them, does not seem to be clearly determined. The post-mortem appearances may be briefly stated to be:—in the neighborhood of the bite, extravasations of blood, and softening of all the tissues; in the internal organs (the brain, spinal cord, and kidneys especially), more or less intense congestion, with ecchymoses in the subperitoneal areolar tissue, and fluidity of the blood mass. Dr. Lacerda Filho is said⁸ to have published, in a Brazilian medical periodical, the following conclusions, based upon experiment: “(1) The poison of the *Crotalus horridus* acts upon the blood by destroying the red blood-corpuscles, and by changing the physical and chemical quality of the plasma; (2) the poison contains some mobile bodies similar to the micrococci of putrefaction; (3) the blood of an animal killed by a snake's bite, when inocu-

¹ W. Ogle, St. George's Hospital Reports, 1868.

² Shapleigh, American Journal of the Medical Sciences, April, 1869.

³ American Journal of the Medical Sciences, July, 1852.

⁴ Ibid., Jan. 1849.

⁵ Op. cit.

⁶ Heidenstam, Lancet, Feb. 19, 1881.

⁷ Indian Annals of Medical Science, quoted in American Journal of the Medical Sciences, April, 1871.

⁸ British Medical Journal, Nov. 12, 1881.

lated in another animal of the same size and species, causes the death of the latter within a few hours, under the same symptoms and with the same changes of the blood; (4) the poison can be dried and preserved for a long time without losing its specific quality; (5) alcohol is the best antidote as yet discovered for this poison." This writer further claims to have ascertained that the venom of the *Hachesis rhambcata* possesses the power of digesting albuminous substances, and emulsifying fats, and infers that the local effects of its inoculation may perhaps be regarded as in effect a digestion of the living tissues. He thinks that it may serve, not only as a means of attack or defence, but may aid in the digestion of the victim. M. Couty, commenting on these statements, points out that "the venom of snakes is not a simple poison, but a pathogenic agent, capable of selecting certain organs and tissues." On its intravenous injection, there always ensue hemorrhages in the lungs, in the endocardium of the left side of the heart and not in that of the right, in the meninges and not in the nerve tissues, less commonly in the stomach, intestines, and kidneys. Different animals show very different degrees of susceptibility; thus, the monkey is said to be about a thousand times as susceptible as the frog. "Many of these poisons, after keeping, contain various bacteria, which can be cultivated, and the culture-liquid, or the fluids from an inflammation due to the poison, cause symptoms different from those of the poison itself, and comparable to simple septicæmia. The venom is thus not an organized virus."

While the foregoing statements may be taken as true, or at least as embodying the general results of observation on snake-poisoning, it is by no means impossible that further study may show that differences exist between the venom of one species and that of another, or, it may even be, between different samples of venom. Fayer thinks that the poison of the *Naja* does not destroy the coagulability of the blood, while that of the *Daboia* makes it perfectly and permanently fluid. Halford¹ described certain cells developed in the blood of animals, killed by snake-poison, which he thought might prove to be a means of diagnosis in doubtful cases; but Mitchell² asserts that these are not new organisms, but only leucocytes, confirming his view by microscopical observations made by Dr. J. G. Richardson. Hodgkinson³ says that the bites of the Australian snakes have less local effect, and exert their influence more upon the general nervous system, than those of the snakes of other countries.

TREATMENT OF SNAKE-BITES.—With regard to the treatment of snake-poisoning, the remedies that have been proposed, and even those that have been declared to be infallible, can scarcely be counted, and it would be simply a waste of time to enumerate them. A few, however, which have been brought forward upon plausible grounds by scientific men, may be mentioned. Bibron's antidote enjoyed a wide reputation for some years; it consists of iodide of potassium, gr. iv; bromine, f3v; corrosive chloride of mercury, gr. ij:—10 drops at a dose. Ammonia has been advocated by various authors for the last seventy years,⁴ notably of late by Halford. Shortt is said⁵ to regard potassa as a reliable antidote, neutralizing the venom. Iodine has been depended upon by others. Dr. Anderson, of Wilmington, North Carolina,⁶ has recorded two cases of rattlesnake-bite successfully treated by means of bromide of po-

¹ British Medical Journal, Dec. 21, 1867.

² American Journal of the Medical Sciences, April, 1870.

³ Ibid., April, 1845.

⁴ First by Mangili, in 1813.

⁵ Letter from Madras, in Medical Times and Gazette, Aug. 23, 1873.

⁶ American Journal of the Medical Sciences, April, 1872.

tassium, and recommends its further trial; he used stimulants also. But the fact seems to be established by the intelligent observations and experiments of Mitchell, Fayrer, and others, that there is no known antidote by which the venom can be neutralized,¹ nor any prophylactic against it. Hence, medication with this view is to be avoided altogether, and the aim of treatment should be to prevent the poison from gaining access to the general circulation, and to obviate its prostrating effects if its entrance has already taken place.

As soon as practicable after the receipt of the wound, a broad ligature should be tied, so tightly as to check the circulation, around the limb above the upper limit of any swelling which may have appeared, and the wound itself should be thoroughly sucked; the poison is harmless when taken into the mouth. Another plan is to apply cupping-glasses over the wound; this mode of treatment was, at one time, strongly advocated, and seemed to produce good results.² Mitchell,³ however, doubts whether sucking can remove any of the poison through the narrow fang-track, and thinks that cupping only delays the poison for the time in the neighborhood of the part bitten. Sometimes the site of the wound is not such as to admit of either of these measures; thus in one fatal case it was on the bridge of the nose. Very prompt cauterization, either with a hot iron or coal, or with the potential cautery—bromine or iodine, solid or in strong tincture—may coagulate the tissues, so as at least in some measure to hinder absorption; the hot iron will actually destroy the venom. Instant excision has seemed, in some cases, to prevent ill effects,⁴ or, in the case of a finger, amputation may be resorted to, as more likely to remove the entire dose of the poison. A plan which has apparently much in its favor, is to slacken the ligature somewhat at intervals, say for five minutes at a time, so as to allow the poison to be admitted little by little, and thus to be dissipated. By slightly shifting the constricting band, so as to change the part of the limb pressed upon, some advantage will be gained. It must be remembered that the continuous application of a tight ligature for twenty-four hours, or even less, would greatly endanger the life of the constricted limb, and, although this would be a less evil than the death of the patient, it is one to be avoided if possible. Fomentations or poultices (a poultice of tobacco-leaves is a favorite Southern and Western remedy) are the best local applications. With these it will, of course, be proper to combine anodynes.

The *constitutional treatment* in these cases is of the utmost importance, but is founded upon the very simple principle of sustaining the strength until the poison shall have been eliminated. To this end, stimulants are given as freely as the patient can bear them. Ammonia is valuable in this way, especially, perhaps, in the earliest stages, where its diffusibility renders its action very speedy. Along with it, and at a later period, whiskey seems to be the most reliable of our resources. Very large quantities have been taken under these circumstances without intoxication being induced. The object is not at all to bring about this condition, which would even favor the injurious effect of the poison, but simply to keep the vascular and nervous system stimulated to the activity required to effect elimination. Should life be maintained, the patient does not for some time feel the need of food; but the addition of

¹ The latest claim of this kind is made in a letter to the *Medical Times and Gazette*, Aug. 27, 1881. The writer says that Dr. Lacerda Filho asserts that the permanganate of potassium is infallible; neither the dose nor the mode of administration is mentioned. Mr. Vincent Richards (quoted in the *British Medical Journal*, Dec. 31, 1881, from the *Indian Medical Gazette*), is said to have found this remedy effectual in neutralizing the cobra-poison. These statements certainly need confirmation.

² See Pennock, *American Journal of the Medical Sciences*, May, 1828; and Rodrigue, *ibid.*, Aug. 1828.

³ *Op. cit.*

⁴ Agnew, *op. cit.*, vol. i. p. 229.

an egg to the whiskey (the two being beaten up together) every two, three, or four hours, would probably prove judicious.

The after-treatment of cases of this kind will suggest itself: a condition of debility often ensues, requiring the free use of the ordinary tonics, quinine, iron, strychnia, and, perhaps, the mineral acids. But, as has been already said, there is sometimes a remarkably rapid return to health upon the elimination of the poison, in which case no after-treatment will be required.

BITES OF OTHER ANIMALS.

The peculiar symptoms often induced by the bites of *rabid* dogs, cats, and other animals of allied tribes, constituting the disease known as hydrophobia, have been made the subject of a special article (vol. i. p. 215). In most cases of this kind, opportunity is afforded to determine, either by previous knowledge or by subsequent observation, whether the animal which inflicted the bite had or had not been hydrophobic. But symptoms, either of this or of other forms of poisoning, to be presently mentioned, occasionally arise from bites inflicted by wild animals, or animals of which nothing is known. Thus a case is reported by Acting-Assistant Surgeon Wolfe, U. S. A.,¹ of a boy, aged 12, who was attacked with a fatal disease, resembling in all respects hydrophobia as ordinarily met with, three weeks after receiving two bites from a *skunk*. Other such cases have been placed on record, and the name "*rabies mephitica*" has been given to the malady. Now it can scarcely be supposed that hydrophobia could prevail among wild beasts, especially as travelers inform us that the disease is wholly unknown among the half-savage dogs which swarm about Constantinople and other eastern cities. Were it otherwise, the propagation of the poison would be so rapid, in the constant fighting of these animals, as to exterminate them in no long time. Hence we must infer, if the facts are known and justly interpreted, either that sporadic cases of hydrophobia do occur among animals, either domesticated or wild, or that the disease may be developed in man by the bite of an animal which is itself healthy.

The bites of *cats*, although sometimes very severe, do not seem to have any special effect in the way of causing blood-poisoning. I have seen one case in which a sick cat bit a servant-girl on the thumb, tearing the tissues deeply for over an inch; the wound was cauterized, and healed kindly, and the patient continued well, to my knowledge, for several years.

Injuries inflicted by the larger felines, as by *lions*, *tigers*, etc., are sometimes met with among the employes of menageries; several such instances have occurred in this city within the last twenty years. A good deal of shock seems to attend these cases, and in one of lion-bite, reported by Dr. John Ashhurst, Jr.,² the rapid occurrence of traumatic or spreading gangrene was a noticeable feature, the patient dying in forty-eight hours. No evidence, however, exists to show that there is any actual blood-poisoning, any more than in injuries of like gravity sustained in railroad or other accidents. The same may be said of the shark-bites occasionally observed along the seashore, or in bathers in large rivers near the ocean. Such cases are not uncommon in India, and several have occurred in New York within a year or two.

One case of apparent blood-poisoning from the bite of a *rat* has come under my own observation,³ and seems of sufficient interest to be detailed here:—

¹ American Journal of the Medical Sciences, Oct. 1875, p. 567.

² See vol. i. p. 567.

³ It was published in the Philadelphia Medical Times, August 1, 1872.

W. T., aged 7, a very stout and healthy boy, was bitten severely in the left forefinger, between the knuckle and the first joint, by a rat which he had caught. Fearing punishment for playing in the street, he concealed the real nature of the injury for two weeks, when I was called to see him. The soft parts about the phalanx were now (June 11) enormously swollen, purplish red, and shining, the hand was somewhat puffy, and a gland as large as a chestnut was felt in the anterior fold of the axilla. The boy had some fever, especially at night, and was listless, and without appetite. Next day I made a free incision into his swollen finger, but very little pus escaped. He was put on the use of the muriated tincture of iron, with a febrifuge at night, and poultices were applied locally. The symptoms all subsided; but on June 18, I was again called to see the patient, as he had a chain of small glandular enlargements all the way up the forearm and arm, while the swollen gland in the axilla had increased to the size of a walnut. By the third day, under hot sponging, all the lumps had gone; but on June 27, he presented a most curious phenomenon; patches, as if the skin had been bruised, very slightly raised, of a pale-purplish, brown, mottled color, extended up the radial side of the forearm, and around the front of the arm to the axilla, up in front of the shoulder, and on the side of the neck to the head. One separate patch existed on the middle of the forearm, and another near the anterior axillary fold. A large patch occupied the axilla. Many similar but less vivid patches existed on the body, and even down on the legs. Each patch had a red rim, clearly marking the line between it and the healthy skin. The only tender patch was that on the left side of the neck; but the boy complained somewhat of soreness, apparently muscular, all over his body. There was no stiffening of the jaws, nor other sign of tetanus. For several nights there was high fever. Under the steady use of the iron, with hot sponging, all these symptoms abated, and on July 2, I ceased attendance. On July 15, I saw the patient again, and found that he occasionally had a re-appearance of the patches, but very faint, and with no constitutional symptoms.

The phenomena here, as in most cases of poisoning by the bites of animals (excepting always the specific ones before referred to), seem to have been those of lymphangitis, with, in this instance, a very mild attack of septicæmia supervening. But they may assume a far graver type; thus Kocher reports a case of acute sepsis, with embolic pyæmia proving fatal in forty-eight hours, which followed the application of a leech to the gum.¹

With regard to the *treatment* of all these cases, it can only be said that it must be based on general principles. Local inflammation is to be combated, and the strength of the patient maintained; the special means of effecting these objects have been elsewhere detailed, and need not be repeated here.

¹ British Medical Journal, Oct. 16, 1880, p. 633.

SABRE AND BAYONET WOUNDS; ARROW WOUNDS.

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SABRE AND BAYONET WOUNDS.

WHILST the injuries inflicted by the *sabre* may be classed among incised wounds, yet they differ among themselves in point of cleanness of cut, according to the sharpness of the weapon and the way in which it is handled. As ordinarily used in war, the *sabre* has a dull edge, like the back of a table knife; rarely are the *sabres* ground. Such a weapon, then, makes a wound by the weight of the blow, not by the velocity of the cut, and the wound which it makes must be more or less contused. Nevertheless, these wounds heal as readily as incised wounds made with keen-edged weapons, although they are more apt than the latter to be followed by noticeable scars. *Sabre*-wounds, and with these I include all sword-wounds, for thrusts with the sword are very rare, are of infrequent occurrence in modern warfare, owing to reduction in the cavalry arm, and to the changes which of late have befallen its functions.

The *bayonet* makes a punctured wound, and, this weapon being more or less blunt, its wound is apt to be a good deal contused. The weapon is triangular in section, and makes a wound with three radiating branches. The spade or trowel bayonet, if it ever wounds at all, will make a wound like any other spade. Like all other punctured wounds in cellular and muscular tissues, the gravity of a bayonet wound depends upon its depth; at the moment of making the wound, the several tissues through which the weapon passes are in different states of tension, and, as soon as the weapon is withdrawn, the several tissues resume their natural state, and thus cause an interruption in the continuity of the wound, or, in mining phrase, produce "faults" in it. If the parts heal by first intention, as they usually do, no harm is done by these "faults," but if pus forms, it will not be able to find its way to the surface by the wound, and hence burrowing and abscesses. These wounds, like *sabre*-wounds, are of very infrequent occurrence. The soldier as a rule dislikes to use his bayonet. I was told by an officer engaged in the Mexican war, in 1846, that, at the capture of the city of Mexico, he saw soldiers firing their muskets into the bodies of certain of the enemy, to whom quarter had been refused, with the bayonets actually resting against the persons of the slain. Both *sabre* and bayonet wounds are quite as often received in private quarrels and disturbances as in battle.

STATISTICS OF SABRE AND BAYONET WOUNDS.—In the British army in the Crimea, about 11,900 wounded men were received into hospital. There were only 76 cases of bayonet wound, with 7 deaths, and 87 of sword wound, with

one death. In the same war there were 2700 killed in action, and, if the same proportion should hold for these, the total number of cases of bayonet wound would be 93, with 24 deaths, and of cases of sword wound 107, with 21 deaths. The records of the Mexican war of 1846 make no distinction between gunshot and sword and bayonet wounds, nor can I find any statistics of the relative frequency of these two classes of wounds in the Franco-German war of 1870. In the late War of the Rebellion, out of a total of 400,000 wounds, there were 22,700 incised and 5900 punctured wounds. But few of these, however, were inflicted with sabre or bayonet. If a man cut his finger while "whittling," and was taken on sick report, he constituted one of the 22,000 subjects of incised wounds. The punctured wounds were usually of the same trivial character. No data exist from which a correct and exact statement can be made of the relative frequency of gunshot wounds and sabre or bayonet wounds during this war. In the Medical and Surgical History of the War of the Rebellion, 481 cases of sabre wound, with 18 deaths, and 188 cases of bayonet wound, with 19 deaths, are noticed, and are explicitly attributed to the weapons named. How many more of the 400,000 wounds were bayonet or sabre wounds cannot now be determined. The fact that these wounds are of very infrequent occurrence, is so well known to military men that it has been proposed by more than one officer to discard both weapons; and, indeed, one of the strongest arguments for the substitution of the trowel-bayonet for the weapon of the old pattern was the fact that the offensive powers of the latter were of so little importance.

SABRE WOUNDS OF THE HEAD.—Of the 282 cases of sabre wound of the *scalp*, recorded in the Medical and Surgical History of the War, 263 ended in complete recovery, while 11 patients were disabled, 3 died from intercurrent disease, and 3 died of the injury. There were 49 cases of wound of the *cranium*, of which 13 terminated fatally, mostly from encephalitis.

In some cases the sabre will completely detach a circular plate of bone, and leave it hanging by the scalp. The proper treatment of such a case is not settled. The temptation, of course, would be to put bone, scalp, and all, back into place, and let them unite, if they would. But it seems to me that the probabilities of non-union, and the risks of necrosis, suppuration, and encephalitis, would greatly outweigh the advantages of having a bony cover for the wound. My own practice would be therefore that recommended by the Historian of the War of the Rebellion, to dissect out the bone, saving the pericranium if possible, and then to hold the soft parts in their place by a sufficiency of antiseptic catgut stitches. In cases of sabre wound of Steno's duct, the experience of our war was that spontaneous healing might be counted on. I myself saw such an event happen, during the war, in a case of gunshot wound of the duct in question, [and an equally fortunate result was obtained, a few years since, in a case of *salivary fistula* resulting from gunshot wound involving this duct, under the care of the Editor.]

SABRE WOUNDS OF THE ABDOMEN.—Sabre wounds of the abdomen are rare, for the dull sabre is incapable of cutting the soft, yielding, abdominal tissues, protected as these are by folds of cloth, and sword stabs are not very common. Our soldiers, contrary to the theoretical teachings which they receive, use the edge of the sword rather than its point.

SABRE WOUNDS OF FOREARM.—Formerly, when duels with swords were more common than at present, the object being to disable rather than to kill an antagonist, wounds of the flexor muscles and tendons of the sword fore-

arm were frequent. These were inflicted by a draw cut of the back of the sabre, which was kept as sharp as a razor for this purpose. Such a wound should be treated, after the arteries are secured, by placing the limb on a splint so arranged as to flex both the fingers and the hand, and by adopting a strictly antiseptic dressing.

BAYONET WOUNDS.—Bayonet wounds penetrating the skull were in our late war generally fatal—four deaths having occurred in five cases. The penetrating bayonet wounds of the chest seem to have been equally fatal, whilst of eleven patients who received bayonet wounds of the abdomen—in some of the cases the bowel was transfixed—eight recovered. The cardinal point in the *treatment* of bayonet wounds is to secure rest. If a limb is hurt, it should be put on a splint, and a bandage applied to keep the muscles quiet, and the patient should be required to keep the horizontal position. If the lung is wounded, opium should be given to secure rest, and Guthrie's rule, to lie upon the wounded side, might be enjoined. If the abdomen has been penetrated, opium must be given in very large doses, or rather very decided effects must be produced by the opium, and the patient's diet must be most strictly guarded. The patient must of course be kept in bed until all risk of peritonitis has passed by.

ARROW WOUNDS.

HISTORY OF ARROW WOUNDS.—The arrow is a weapon of the greatest antiquity. Not only can we infer its possession by primitive man, from its use at the present day by the most savage tribes, but the earliest writings and the oldest sculptures, and the treasures of the caves, all testify that from its infancy the human race has drawn the bow. Accordingly we find that the arrow was of particular interest to the surgeons of antiquity, who discussed at length the wounds which it caused, giving specific rules for the treatment of the wounded, and inventing instruments for the removal of the missile. Homer, in the *Iliad*, tells us at length of the wounding of Machaon by the arrow of Paris, and in another place is described some bad surgery of Machaon's, in which Menelaus, wounded by an arrow, was the sufferer. The Father of Medicine devoted a book, but unfortunately one of the lost books, to missiles and the wounds made by them. Celsus gives a chapter to arrow wounds, and from him we know pretty much all that is known of these lesions as they were seen in his day. Celsus lays down some excellent rules for the treatment of these wounds: thus he advises free dilatation with the knife, to allow perfect exploration by the finger, and teaches that an arrow may be removed as well and very often better by pushing it forward to emergence, than by pulling it back over the course already taken.¹ Paulus Ægineta² merely reiterates the teachings of Celsus, as does Albucasis.³

The ancients surpassed our Indians in the destructiveness of their invention, for they contrived arrow heads with barbs pointing forwards as well as backwards, and attached scraps of metal, which might be unwittingly left behind by the surgeon, if he should be so skilful as to extract a doubly-barbed arrow. They had, besides, a crescentiform arrow head with a keen edge, with which instrument a man could almost be decapitated.

Paré gives considerable space to arrow and spear wounds. In his day, the arrow was fastened to the shaft in two different ways. Most commonly, the arrow head at its base terminated in a spike, which was driven into the

¹ *Medicinæ*, lib. vii. cap. v.

² *Lib.* vi. cap. lxxxviii.

³ *Chirurgia*, lib. ii.

wooden shaft, but other heads had thimble-shaped sockets, into which the wooden shaft was driven. Some of these last described were composed of several parts, one arrow head being nested over another, frequently to the number of five. Paré's forceps for extracting these arrow heads was shaped like a glove-stretcher. Its beak entered the socket, and, on pressing the handles together, made sufficient outward pressure to hold the foreign body during its extraction.¹ Grose² says that the English arrow was from twenty-seven to forty inches long, that its range was from 120 to 360 yards, and that English archers could easily shoot through an inch plank. Archers constituted a part of the English army as late as the time of the Great Rebellion, and several important battles were decided by the bow and arrow, the battle of Hastings being the most important of all; nor is it impossible that the bow and arrow may again become a military weapon, and a very formidable one, in the hands of cavalry.³

ARROW OF THE NORTH AMERICAN INDIAN.—The arrow of the North American Indian usually consists of three parts: a head, a shaft, and a band that binds head and shaft together. The *head* is made of bone, of iron, of one of the silicious minerals, or even of glass. The *stone* or *glass* arrow head is made by trimming a fragment of agate, flint, obsidian, or bottle glass, into a cuneiform shape. This is done by holding the fragment in the left hand, and breaking off its edges, bit by bit, by means of a bone having a shallow groove cut around one of its ends. The edge of the glass is caught in this groove, and the thumb is used as a fulcrum.⁴ These arrow heads have no neck; they are about an inch long, and a third of an inch wide. They are fastened by gum into a notch, which is cut in a rod of wood eight inches long, and this again is fastened by gum into a reed thirty inches long; but so frail is the connection between head and shaft, that the Indian is obliged to take extraordinary care that they do not become separated in the quiver.⁵ These heads are of course brittle, and if they strike a bone, they are sure to break. Mr. V., a paymaster and clerk, was thus wounded in the arm by an Apache arrow. The glass head struck the humerus, and broke into many fragments, which were a long time in coming away.⁶ The *metallic* head is usually made from soft hoop-iron, by aid of a sandstone hone. This head is from half an inch to an inch broad, and from one to three inches long, and of the well-known shape; its edges are dull-sharp, like those of an oyster knife, and it has at its base a small quadrangular stem or neck for attachment to the shaft. Usually it is not barbed.

The *shaft* of the arrow is made from the sapling of the willow or dogwood tree. A bundle of these saplings is thrown into a warm pool, and soaked until the bark can be easily peeled off. Each sapling is then straightened in this way: Pieces of wood are first firmly lashed to the ends of the saplings, crosswise; one of these crosspieces is held between the feet, and the other is held in the hand; a to-and-fro, semi-rotary motion, as in trephining, is given to the crosspiece in the hand. Thus the fibres of the stick become

¹ Œuvres complètes d'Ambroise Paré, ed. par J. F. Malgaigne, tome ii. p. 183. Consult also Daniel, *Historie de la Milice Française*, tome i. p. 303. Amsterdam, 1724.

² *Military Antiquities respecting a History of the English Army*, etc., p. 268, 1801.

³ On the shapes and sizes of the arrows of the Middle Ages, consult Hewitt, *Ancient Armor and Weapons in Europe*, etc., vol. i. pp. 23-65, 1865; also Matthew Paris, *Historia Major*, pp. 1090-1091. Paris, 1644.

⁴ Consult Report of Explorations for a Route for the Pacific Railroad, on the trail of the 41st parallel, North Latitude. Senate Document, 33d Congress, p. 43.

⁵ Consult Notes on Arrow Wounds, by Elliot Coues, Assistant Surgeon, U. S. Army. *Medical and Surgical Reporter*, April, 1866.

⁶ Unpublished Notes of Cases in the Office of the Surgeon-General, U. S. Army.

untwisted, and it is easily made straight. It is then confined in this straight condition on a flat rock, by superimposed weights, until it becomes dry, when it remains straight. It is next cut to the length approved by the archer who has fashioned it, a length ranging from twenty-six to thirty-four inches. A slit is made at one end to hold the neck of the iron head, a notch at the other to receive the bow-string and the feathering that is to steady its course, and the shaft is done.

The third part of the arrow is the *clamp* that binds head and shaft together. This is a flat piece of sinew, or tendinous ribband. The neck of the arrow-head having been pushed into its place in the slit of the shaft, the well-soaked sinew is tightly wrapped around the joint. As it dries, it contracts, and so pinches together the sides of the cleft. Thus by its embrace, a bit of iron and an innocent stick are transformed into an inflexible, dangerous weapon, for, as will appear, much of the danger of arrow wounds depends upon this peculiarity of construction.

BIRD ARROW.—The bird arrow, consisting of a simple shaft, its end pointed and hardened by fire, is sometimes used in war. Thus Mr. Evans was wounded in the top of his left lung by a bird arrow, which he plucked away at once. He died two weeks afterwards.¹

RANGE AND PENETRATION OF ARROWS.—Although the distance at which arrow fire is effective, is not great—being less than 100 yards—the penetrativeness of the missile itself, even at far range, is surprising. I have seen an arrow, discharged from the distance of an hundred yards, so deeply imbedded in an oak plank that it could not be removed by any force directly applied. I have often had occasion to notice the tightness with which an arrow-head is held, when it has penetrated a bone. It is usually impossible to remove it by direct traction. The Indian highly prizes this power of penetration, and increases it by skill and practice. An arrow which has been shot in the chase through the body of a buffalo, is carefully treasured and decorated, and, when worn on festal days, marks its owner as a man of the most worshipful skill. There are numerous specimens in the Army Medical Museum proving the

Fig. 240.



Penetration of superciliary ridge and brain by an arrow. (A. M. M., Sect. I. Spec. 5644.)

Fig. 241.

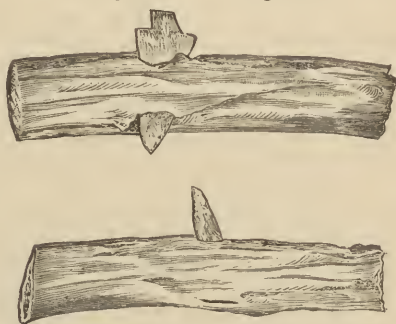


Fig. 242.

Ribs of buffalo transfixd by arrows. (A. M. M., Sect. I. Spéc. 4735, 4736.)

penetrativeness of the arrow. Among these, I have selected three, represented in Figs. 240, 241, and 242. In the former, an arrow has gone through the thickest part of the superciliary ridge, and then four inches into the brain. Figs. 241 and 242 show ribs of the buffalo transfixd by arrow heads.

¹ Unpublished Notes on Arrow Wounds in the Office of the Surgeon-General, U. S. Army.

CORRECTNESS OF AIM AND RAPIDITY OF DISCHARGE.—The arrow can be aimed at fifty yards as correctly as the revolver, and can be shot nearly as fast. At close quarters, and in a *mêlée*, it is a weapon more to be trusted than the pistol. It is not common to find a man killed who presents but one arrow wound: usually he will have received three or four; I have counted thirteen in one corpse. In 1872, two Indian scouts were found dead near Fort Rice, the two having been pierced by thirty arrows.¹ An expert archer will easily deliver six arrows in a minute, for he does not aim with the eye, drawing the string to the shoulder, but simply points the arrow, both arms being extended, and the hand which holds the bow grasping at the same time a sheaf of arrows. These are not shot away wantonly, for their manufacture costs the lazy Indian too much work, but in the frenzy of the fray; just as a dog, when excited, will rend the victim which he ordinarily loathes.

POISONED ARROWS.—After a residence among a number of our Indian tribes, and careful reference to authorities, I am satisfied that the North American Indian does not use poison on his arrow, at least not designedly. It is probable that in those cases in which poison seemed to have been carried by an arrow, it has infected the arrow accidentally, as may easily occur in view of the squalor and disregard of sanitary requirements in which the Indian lives. When arrows are prepared for war by dipping them in blood, etc., I believe that this is done from superstitious motives—a baptism of *fetich*, as it were. But a consideration of the subject, as already set forth, and as will be further developed, will show that poison is not needed to make the arrow a most effective weapon; its silence, its penetrativeness, the difficulty with which it is removed, the rapidity with which it is discharged, and its correctness of flight, all confer upon it the highest deadliness. While this more particularly concerns the soldier, we shall find much in the character and treatment of arrow wounds to interest the surgeon.

APPEARANCE OF ARROW WOUNDS.—The arrow makes a wound which is at the same time punctured and incised. Thus, while on the one hand, owing to its high velocity, it rarely fails to lay open any viscus or to divide any vessel which it touches, it makes, on the other hand, a well-like wound, like that inflicted by the bayonet. But owing to its high velocity, the wounds made by an arrow oftener preserve their continuity (like gunshot wounds received at close range) than do bayonet wounds, which, as already pointed out, by becoming discontinuous, prevent the outward flow of discharges, and so give rise to abscesses. The cleanness of cut which characterizes arrow wounds also renders them less apt to suppurate than other punctured wounds. If an arrow has passed completely through a fleshy part, we find the two orifices differing in appearance. The wound of entrance looks like that made by a small pistol ball, a slit being found in the skin, which may be darkened and bruised, and slightly depressed. The wound of exit is a simple slit. When only one wound is found, the shaft having been plucked away, a question may arise as to whether the injury has been caused by an arrow or by a bullet.

After the attack by Navajoe Indians on Fort Defiance, in 1860, a soldier was found dead with a small wound just below the left nipple. The external wound looked like that made by a small conical ball, and it was thought that the man had met his death in a gambling quarrel at the hands of his comrades. But an examination of the interior of the chest showed that the vena cava was pinned to a rib by an arrow head, which had also passed through the heart. In all probability, the shaft had been removed by the archer.

¹ Unpublished Memoranda in Office of Surgeon-General, U. S. Army.

An arrow may make a simple incised wound, several inches in length. Thus, if an arrow head strikes the skin obliquely, particularly at some spot where it is closely drawn over bone—as over the ulna, the tibia, or the cranium—a long cut with clear edges will result.

PARTS OFTENEST WOUNDED.—In the annexed table is shown the liability of the several regions of the body to be wounded, and the relative fatality of these wounds:—

	Head or spinal column.		Neck and trunk.	Thorax.		Heart.	Abdomen.		Upper extremities.	Lower extremities.	Total.
	Contents wounded	Contents not wounded		Lung wounded	Lung not wounded		Cavity penetrated.	Cavity not penetrated.			
Recovered	2	4	12	5	10	...	2	11	44	17	107
Died	7	...	1	13	...	2	18	3	2	1	47
Cases	9	4	13	18	10	2	20	14	46	18	154

The above table is founded upon some seventy cases of arrow wound which fell under the notice of the writer in 1860, and an account of which was published in the *American Journal of the Medical Sciences* for October, 1862, together with other cases which have occurred since—some reported to the Surgeon-General of the United States Army, and published in Circular No. 3, S. G. O., 1871; others as yet unpublished; and five reported in the *Philadelphia Medical and Surgical Reporter* for January, 1864, by Assistant-Surgeon Elliot Coues, U. S. Army.

The *upper extremity* is oftenest wounded, not only because it is most exposed, but also because an arrow can be seen as it advances, and the arm, being instinctively raised to ward off the missile, thus receives its point. Wounds which penetrate the *abdominal cavity*, and injure its vessels or viscera, are the most fatal. Knowing this, the Indian, if he has time to deliberate, points his arrow and lance at the abdomen, while the Mexican protects this part with special care, by covering it with many folds of a blanket. As already stated, multiple arrow wounds are the rule. In the above table, in each case in which there were multiple arrow wounds, the most serious, or the fatal wound, only is recorded.

CAUSES OF DEATH.—The following table exhibits the causes of death in thirty-nine cases of arrow wound, in which this was ascertained:—

Cause of death.	Immediate hemorrhage.	Peritonitis	Compression of brain.	Encephalitis.	Empyema.	Tetanus.	Pneumonia.	Paralysis from wound of cord.	Wound of heart. (Shock?)
Number of cases }	10	16	4	3	1	1	1	1	2

PROGNOSIS.—The prognosis in a case of arrow wound depends on several circumstances. It is influenced, in the first place, by the *nature of the parts wounded*. Vessels and intestines are not pushed aside, as they frequently are by bullets, but are laid open; fecal matter may be thus thrown into the peritoneum, or a hemorrhage, sufficient to determine the fatal issue, may take place before the case is seen by the surgeon. Not only have we to consider the blood already lost, but that which is likely to be lost in extracting the

missile, or in securing the wounded vessel. The first of the preceding tables shows, however, that arrow wounds of the abdominal cavity are not invariably mortal. Secondly, in considering the prognosis, we should regard the *chances of extricating the arrow head*, if this has lodged. If the shaft remains attached to the head, the operation will probably be successful; but if the head is lost in the soft tissues, or is left in the chest or abdomen, its removal will be difficult and perhaps impossible. If, however, the foreign body be not extracted, it will sooner or later bring about the death of the patient, for, unlike a smooth ball, the arrow head—long, sharp on the edges, angular, perhaps serrated—will not become encysted. Other considerations, too, not peculiar to arrow wounds, affect the prognosis; such as the health of the patient, the immediate importance of the wounded parts to life, the liability to inflammation, and especially the courage or mental serenity of the sufferer. The presence of shock shows that an organ essential to life, or highly innervated from the sympathetic system, has been seriously hurt, for ordinarily there is no shock at all. Wounds of the joints generally do well, and destructive inflammation of the synovial membranes is not likely to occur.

TREATMENT OF ARROW WOUNDS IN GENERAL.—If an arrow has struck a fleshy part, such as the outer side of the thigh, and has *passed completely out*, but little need be done. The wound should be encouraged to heal by first intention, and to this end perfect rest, both general and local, should be enforced. If a limb is hurt, it is well to place it on a light splint, and to apply a bandage firmly, so as to quiet muscular action. On the high, dry table-lands of Colorado and New Mexico, these wounds will often heal in two or three days. Hæmatomata may form, but, even under these circumstances, we may frequently get absorption without the formation of pus. If an abscess has formed, it should be opened according to general rules.

If the whole arrow—head and shaft still bound together—has *lodged*, we must first determine whether or not the head is impacted in the bone. This can be ascertained by gently twirling the shaft between the finger and thumb, or by trying to push it a little forwards—never by pulling it back. The slightest mobility settles the question, and the greatest care must be taken not to separate the head and shaft in the examination. If the head is not fixed in the bone, we next consider whether the missile shall be *pulled out* over the course it has already taken, or whether it shall be *pushed out* through the tissues which it would have traversed, had its progress not been arrested. This will depend upon how deeply the missile has penetrated, and upon what tissues it must encounter in a forward course. If it is decided to *push out* an arrow, we oil the shaft, and make firm pressure on its end. When the head is felt under the skin, it should be released by a touch of the knife. The head and tendinous ribband are then removed, when the shaft is withdrawn with a gentle rotary motion. In this case too, where we artificially make the arrow do what it would have done had its progress not been stayed, we get a cure without suppuration. But if the ribband of tendon has been left in the wound, or if, for any reason, such as inability to secure rest for the parts, we expect suppuration, then, before withdrawing the shaft, it is well to fasten to this a drainage-tube, and to drag the latter into the wound as the former is plucked out. Some carbolized oil may be injected into the tube, which should be left in place until suppuration commences; then the tube with a pledget of lint may be drawn through the wound, and the missing tendinous ribband be thus brought away. Further search for this will usually be inexpedient.

If it is not feasible to *push* the arrow out, we must *pluck* it out, and, to do this, the head itself must be seized. But the shaft is so tightly grasped by

the skin and other tissues that not even a probe, much less the finger or forceps, can be carried down to the head. A deep incision, using the arrow shaft as a guide, must therefore first be made with a probe-pointed bistoury, sufficiently free to permit the finger to pass down and touch the arrow head. After the position of the latter has been ascertained by the finger, a pair of long dressing forceps, applied to the flat sides of the head, will suffice for its removal. I would urge that this should be done with the greatest care, lest the head should be separated from the shaft. So easily may this accident occur, and so unfortunate are its results, that this manœuvre with the forceps must always be a matter of anxiety to the surgeon.

If the arrow head is deeply lodged, or if it has penetrated the chest or abdomen, some other instrument than a dressing forceps will be necessary. If the arrow forceps, to be presently described, is not at hand, a loop one-quarter of an inch in diameter should be made on a stout wire, and this loop, having been bent at right angles to the body of the wire, should be carried down beyond the point of the arrow head, and so manipulated as to snare the latter. In doing this, a forked probe, like that used in the operation for vaginal fistulæ, or the old fashioned *porte-mèche* (Fig. 40, Vol. I. p. 487) will be of the greatest assistance. Fig. 243 shows the application of the loop to

Fig. 243.



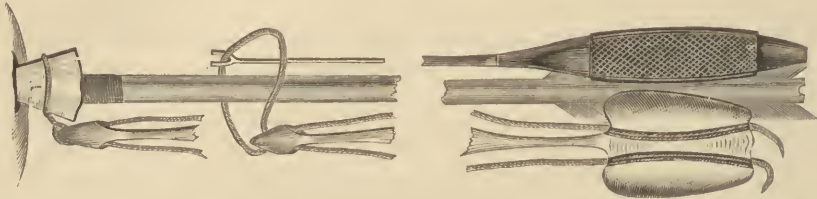
Wire loop applied to arrow head.

the arrow head. When the loop has embraced the head with a very gentle pressure, the wire should be firmly lashed to the shaft of the arrow, and then gentle traction should be applied to this, the finger being kept as deeply in the wound as possible. It is best not to pull directly on the wire itself, but to use this only as a kind of clamp, to make the arrow head fast to the shaft, making traction on the latter. In this way, if any tissue which it is desirable not to cut, should be pinched between the wire and the edges of the arrow head, it will be less likely to be wounded. As soon as the head is drawn within reach of the finger, the dressing forceps should be applied. The loop should be used for arrow heads not lodged in bone, only to draw the missile within reach. In making the incision with the bistoury, it is better to make it too large than too small. It must allow perfect freedom for the manipulation of any instrument, and especially for that best of instruments, the index-finger.

If the arrow head has *lodged in a bone*, and the arrow forceps is not at hand, the wire loop must be applied in a different way, and considerable force may be required to unseat the foreign body. The shaft in this case should be cut off with pliers, the wound well dilated, and, if possible, the position of the arrow head ascertained with the finger. Then a loop of stout but flexible wire—the ends being threaded into a Coghill's suture twister—is slipped over the remnant of the shaft, and, by means of the twister and a *porte-mèche*, is pushed down until it has passed over the arrow head, which it is made to encircle loosely. The wires are then drawn tight and fastened to the handles of the twister, and the latter having been rotated once or twice, the loop will be firmly attached to the head, from which it cannot slip owing to the wedge shape of the latter. Figure 244 shows the application of the twister and loop. The arrow shaft and the twister having been lashed together, the two may be gently twisted or rocked from side to side as one system, whilst traction is made by the handles of the twister. If force enough be used, and if the wire do not break, the arrow head will come out. If the wire should

appear too weak, and likely to break, a second loop should be cast around the head by means of another twister, before traction is made. Any amount of force may be applied by fastening both twist-ers to an inflexible rod, one end of which rests upon a block placed upon the patient's body, and then using this rod as a lever of the second order. Force is thus applied evenly and

Fig. 244.

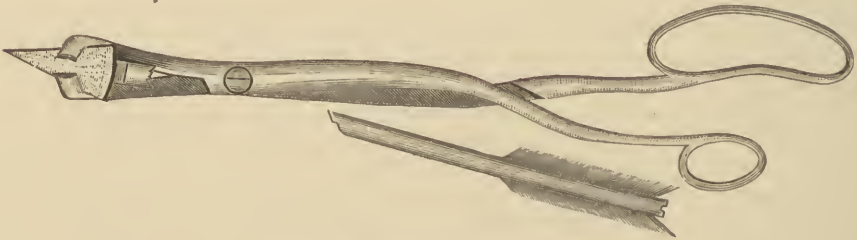


Application of wire loop to arrow head embedded in bone; the loop is adjusted by aid of the wire twister and *porte-mèche*.

without jerking. The *écraseur* and wire cable used for crushing piles, or two catheters soldered together, may be used instead of the twister, though this can be made by any blacksmith.

I think, however, that the forceps which I have devised for extracting arrows, will be found more convenient in all cases than any arrangement of loops. The instrument is represented in Fig. 245. The jaws are flat, and are

Fig. 245.



Strong forceps for extraction of arrows.

bent at right angles to the handle, and they form, when closed, an elliptical loop adapted to embrace the head as a dagger is embraced by its sheath. For convenience and certainty of passing these forceps down to the arrow head, the face of the jaws, close to their edges, is grooved so as to fit and slide along the round arrow shaft, which is thus used as a director. The joint is made like that of a dentist's forceps, so as to allow of any amount of twisting without bending, and, in order to make the instrument still stronger as a twister, one of the handles is mortised, and into this the other handle is made to fit, being tenon-shaped through nearly its whole length. The handles are eight inches long to the fulcrum, and are made very strong in themselves as well as by their mortise and tenon construction. From the tip of the jaws to the fulcrum is two and a quarter inches. When the arrow shaft is in place, the instrument is slid down upon this as a director, until the head is reached, when the jaws are opened, and made to grasp the head by its edges, encircling it almost like a loop. The handles having been then tied together for security, a gentle but decided twist will unseat the arrow head as easily as a dentist twists out a bicuspid tooth. If the head is not lodged in bone, the forceps are passed, closed, beyond its point, and the jaws are used as a loop to catch the latter without being opened at all.

The removal of an arrow head *after the shaft has been separated from it*, is always difficult, and frequently impossible. The ancient writers rather made light of arrow heads hidden in the tissues, and there are, in the Army Medical Museum, at Washington, specimens of flint arrow heads, lodged and encapsuled in bone. But who can say what trouble these foreign bodies may not have given during life, and whether they may not have been, indirectly at least, the cause of death? In my own experience, as well as in that of several of my colleagues, the lodgment of an iron arrow head in soft tissues or in bone, will ultimately produce fatal mischief. I have never seen an arrow head left behind after the withdrawal of its shaft, but it sooner or later required removal, to preserve limb or to save life. In 1862, in an article which I published in the *American Journal of the Medical Sciences*, I wrote: "An arrow head cannot become encysted like a ball; it presents too many sharp angles and edges, and is generally too irritating for any such event to be expected. . . . The inflammation it produces is the effort of nature to throw off the foreign body." I might have added that this inflammation will continue as long as the patient lives, unless the foreign body be thrown off by nature, or removed by art.

The case of the late General (then Lieutenant) Bayard, of the U. S. Cavalry, as narrated by Dr. C. A. Pope,¹ may be quoted in illustration of this doctrine, and may serve to exemplify the characteristics of a case of arrow wound in which the head has lodged:—

The spear-shaped iron point, two and three-quarter inches long, . . . entered the face a little below the orbit, and was completely embedded up to the shoulder, the small neck alone remaining in the flesh. Its direction was backwards and slightly outwards. The surgeon of the Post immediately endeavored to extract the foreign body; . . . various means with forceps were resorted to, and, after a trial of two hours, the effort of extraction was abandoned. The absence of a suitable instrument, the slight hold which could be obtained on the offending body, and, above all, the firm impaction, sufficiently accounted for the failure. (Slight secondary hemorrhage from the nose followed within a few weeks, and again a more serious bleeding occurred while the patient was on his way home.) The patient arrived at St. Louis five weeks after the receipt of the injury, and I visited him immediately. There was some enlargement of the left side of the face. The wound on the cheek had skinned over, so that no foreign substance could be seen; . . . a muco-purulent discharge, which came doubtless from the antrum, issued from the corresponding nostril. On incising the imperfect cicatrix, I felt the small neck, and, supposing that the arrow head, after so long a time, might be loosened, I attempted its extraction with the dressing forceps of my pocket case, but failed. I at once supplied myself with instruments of various kinds, but succeeded in the first attempt with powerful forceps. A smart hemorrhage from the nostril and external wound immediately followed. By rest, cold, the administration of opium, plugging, and bandaging, the bleeding was soon arrested. The case now seemed to progress favorably, and the patient was able to get about the streets. On a visit to my office, he complained of a stiffness and inability to open his jaws as widely as usual—a difficulty indeed which had existed all along, and which was the result of the general thickening of the parts from inflammatory exudation. I advised him to make gentle efforts to open the mouth. In less than an hour from this time, his troubles commenced. The whole cheek became hot, swollen, and painful. High fever with renewed bleeding set in, and caused me much anxiety. The means which before were successful, now failed. Extensive extravasation of blood took place, and, to relieve the tension, I made an incision in the mouth, and others on the cheek and neck, thus allowing the discharge of large grumous clots. The hemorrhage continuing at intervals, occurring with regularity about twelve o'clock on three successive nights, and the patient being reduced to the lowest point of safety, I determined to tie the carotid artery without delay. This was done by candle-light on the night of the 16th of September, two

¹ St. Louis Medical Journal, 1864, p. 12, and Hamilton's Military Surgery, p. 544.

months after the receipt of the injury. (The operation, though done under the most unfavorable conditions as regarded its time and the state of the patient, was successful. The bleeding never recurred, and the final recovery of the patient was complete.)

Let it be received then as a rule without exception, that an arrow head left behind and lodged in the tissues must be removed as soon as possible, even if this removal should require the severest and most dangerous of operations. Accordingly, as soon as a patient presents himself, and, if possible, before the wound made by the shaft and head has closed, search should be made for the foreign body. A probe should be introduced, and carried along the course of the wound as far as possible, until the arrow head is reached. If a false passage is made, the probe should be left where it has lodged, and a second one taken, and this manœuvre repeated until the true passage is found. Of course the patient is placed in the attitude which he held when wounded, and the wound itself is injected with carbolized oil, so as to deaden sensibility and diminish reflex muscular action. If the probe has penetrated for some distance into the tissues, and if, though we feel sure that it has followed the course of the wound, its progress has become arrested, it is well to lay the wound open to the depth reached by the probe, using this as a guide. At the bottom of the wound so made, we may be able to find again the track of the arrow, or perhaps to feel the head with the finger. In any event, such a wound is of trifling consequence in comparison with the important result that may be got from it. But sometimes the most patient and boldest searches fail to discover the arrow head. There is then nothing to do but to wait. Perhaps an abscess will form, and in it we may find the offending body. To save life, it may be necessary to amputate the limb.

In these searches for hidden arrow heads, it should be remembered that the course of the arrow is always straight through the tissues, and that therefore an incision carried down in the direction which the arrow had on entering, will reach its head. There is greater hope then from exploratory incisions in arrow wounds than in gunshot wounds. But even if the probe, successfully carried through the wound, should strike the iron head, still, there might be doubt. The foreign body is small and light, and usually presents, not its flat side, but its sharp edges to the contact of the probe. The finger only can give certainty, and to apply this instrument a long, deep incision may be necessary. Before making this, however, and in order to avoid doing so, a plan that I have practised, though unsuccessfully, may be tried. A pair of long, slender forceps may be introduced alongside of the probe, and carried on until the body supposed to be the arrow head is reached. Then the forceps are opened, and an effort is made to cause its jaws to strike the flat side of the head, one jaw above and the other below, the head lying between them as the forceps are shut and opened. The trouble which I found in this exploration, was to manipulate ordinary forceps in so deep and narrow a wound; but the modification of the Mathieu "crocodile" forceps which I have had made for extraction of balls (Fig. 246), would probably answer the purpose.¹

If the head has been found, no hesitation or delay should occur in extract-

¹ The magnetic probe of the writer may also be used with advantage in these cases of doubt. It consists of a steel probe, made from a coarse knitting needle, highly magnetized. Over one of the poles is wrapped from seventy-five to a hundred feet of No. 40 insulated copper wire, so as to form a spindle-shaped bulb, about an inch long and from a fifth to a quarter of an inch in diameter. This bulb is covered with catheter varnish, or asphaltum varnish. The steel magnet projects from the bulb from an eighth to a sixth of an inch, according to the length of the probe. The wires from the bulb are connected with the audient of a telephone. On touching the end of the magnet which projects beyond the bulb, to a bit of iron, a momentary, induced current of electricity is, at the time of contact, developed in the coil of wire forming the bulb, and this current, passing to the audient, manifests itself there by a grating click. (See American Journal of the Medical Sciences, January, 1881.)

ing it. Ordinarily the arrow forceps, applied to its edges, will bring it away safely enough, even without an incision. If the head is lodged in bone, the forceps should be used as the dentist uses the bicuspid forceps, giving a slight twist to unseat the foreign body, before making traction. I reiterate,

Fig. 246.

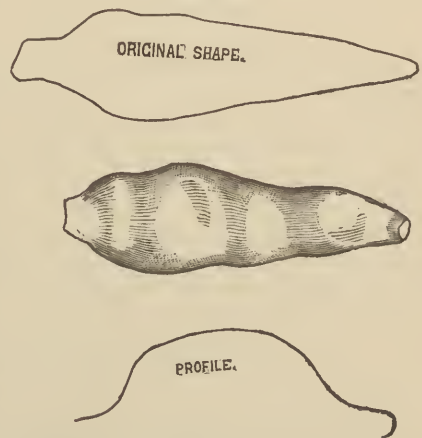


Modified "crocodile" forceps.

and would lay it down as a cardinal rule, that an arrow head must never be left in the body, unless patient search has failed to find it. I wrote in 1862, and think yet: "We might as well cut the patient's limb up until we do find the arrow head;" for, if it is left, amputation will be necessary, and worse than this can hardly ensue from the dissection advised. If I should undertake such an operation, I would make up my mind to find the arrow head, even if it became necessary to tear up every fasciculus of every muscle in the injured member.

Before leaving the general consideration of arrow wounds, I should mention a complication peculiar to the lodgment of the iron arrow head, a complication which renders its extrusion by natural processes impossible, and its extraction by art very difficult. If a soft iron arrow head strikes a bone obliquely, or slips between it and its periosteum, or if the muscles contract as the shaft passes through them—the point of the head being at the same time in some dense tissue, such as bone or cartilage—the point is bent. This bending increases as the arrow goes on, until at last the whole head will have been transformed into a hook. A little reflection will show how powerless the wounded part must be to throw off the intruder, and how hard it will be to remove it by forceps, unless we make allowance for its change of shape. The appearance of an arrow head thus distorted is represented in Fig. 247, from a case reported by Surgeon B. A. Clements, U. S. Army.¹ In a case occurring in the practice of the late Dr. Kennon, of Albuquerque, New Mexico, the femur was found half encircled by a hoop-iron arrow head, which had produced caries, abscess, and infiltration, and was only removed at last after a severe operation. The chance in any given case that the arrow head may have been thus bent, gives additional force to the rule of always searching the wound with the finger as a probe.

Fig. 247.



Bending of arrow heads. (After Clements.)

Unless the surgeon sees the patient very soon after the plucking out of

¹ Hamilton's Military Surgery, p. 530.

the shaft, he will probably fail to find the foreign body. To leave the shaft intact, or to cut it off carefully an inch from the surface, for convenience of transportation, is the safety of the patient. Soldiers, or those liable to be wounded by arrows, should understand the danger of meddling with an implanted shaft, and every effort should be made to keep this in its place until proper surgical aid can be given. Not only is the presence of the shaft necessary for the easy finding of the head, but it will be the best guide in case it should be necessary to cut for and tie some wounded vessel.

TREATMENT OF WOUNDS OF SPECIAL PARTS. *Nerves.*—If a nerve has been partially divided, or if such an accident is suspected, it is right to cut down to the nerve supposed to be injured, and complete its division. Our knowledge of the cutaneous distribution of the nerves will aid us in determining the particular nerve which has been hurt. Thus, in a case which I saw in 1860, in which an arrow passed through the middle of the leg, I inferred from the intense pain felt in the fibular side of the foot, that the musculo-cutaneous nerve had been injured, and a small incision showed that nerve to be partly divided. I completed the division with the knife, giving immediate relief from pain, and without producing permanent inconvenience to the patient. I think that this would be the correct treatment even if a nerve as large as the sciatic were partly divided.

Wounds of Vessels.—If an arrow divides or wounds an artery or vein, and the hemorrhage demands it, we must search for the bleeding point, using the shaft as a director. Then we should act according to circumstances. If the vessel be a small artery or vein, its complete division will probably check the hemorrhage. If the ligature is required, we must apply the thread both to the cardiac and to the distal end of the divided artery; it is well to knot the ligature belonging to the cardiac end, for purposes of distinction. As long as the shaft remains in the wound, there will be little hemorrhage, especially if a bandage be rather tightly applied to the limb, the shaft serving as a means of making pressure on the wounded vessel.

Arrow Wounds of Joints.—Usually arrow wounds of the joints do very well, but I can imagine a particular case which would involve the greatest danger. If an arrow shot with force should deeply penetrate the cancellous structure of the femoral condyles, and bury itself so deeply as to make the grasp of forceps unavailing—the joint of course being implicated—the patient would be in the greatest peril. He would probably die if the foreign body should not be removed, and it could be removed only by a resection of the joint, or by amputation. Although I have never seen such a case, it might well occur, for an arrow head could readily penetrate so deeply into the thigh bone that not even the neck of the weapon would project. Perhaps in such a case the best course would be to employ expectant measures during the acute stage, and resort to secondary excision at a later period.

Arrow Wounds of the Head.—If an arrow strikes the calvaria at right angles, it will penetrate, provided that it has not lost its momentum,—the danger to the patient depending upon the depth of penetration and the locality of the wound. If one of the large sinuses or the important parts of the brain be injured, immediate death may follow. So perished Lieutenant Maxwell, of the Second U. S. Infantry, by an arrow wound of the superior longitudinal sinus. There are numerous specimens in the Army Medical Museum showing arrow wounds of the calvaria. In specimen No. 5644, represented by Fig. 240, the arrow went through the thickest part of the

superciliary ridge, and penetrated deeply into the brain, and yet its presence was hardly suspected during life. If an arrow has penetrated but a short distance—as a quarter of an inch—into the skull, and the patient has symptoms of cerebral compression, the probabilities are that a scale of bone from the vitreous table has been broken off, and, still sticking to the point of the arrow head, is making pressure on the brain. I have seen a patient with an arrow slightly penetrating the skull, immediately recover consciousness on the removal of the foreign body. It is probable that, in plucking out the arrow head, I drew back into its place a scale of bone which had been broken off from the inner table, and driven in against the brain. In two other cases of arrow wound of the skull—not, however, seen during life—I found by an autopsy, that this depression of the inner table had occurred. The scale of bone was in each case spiked by the arrow point, and borne firmly against the dura mater and brain. The men had evidently been rendered insensible by the wounds in their skulls, for both had perished from other wounds received at close quarters. I think that this casualty is of rather frequent occurrence, and although there is no example of it in the Army Medical Museum, it must be remembered that this accident would immediately render the wounded man a prey to the savage who had shot him, and, after being scalped and otherwise mutilated, he would be left dead on the field, or possibly buried where he fell. Thus it would not be probable that any specimens would be procured.

The immediate danger in arrow wounds of the skull, is from internal *hemorrhage*; and we infer that this has taken place if the symptoms of compression remain after the arrow head has been withdrawn. If the arrow head has gone in very deeply, a large trephine should be applied, and the circle of bone and arrow head may then come away together. Next, any superficial bleeding vessels should be looked for, and twisted, or, if they are lodged in bony canals, such as the meningeal, the wound should be plugged with lint. The exposure of the deeper parts to the air would at once give outward vent to the blood, thus relieving the compression, and at the same time constricting the vessels and so stopping the hemorrhage.

Encephalitis is the secondary danger to which the victims of arrow wounds of the skull are exposed. If the arrow head is removed, this inflammation will usually not be serious, and will yield to purgatives, ice, aconite, and rest. But if the arrow head is not removed, the irritation will produce abscess, which will probably prove fatal. In these cases the patient is usually conscious, and perhaps unaware that an arrow head is lodged in his brain, and quite skeptical as to the ultimate danger. If, after a cautious examination with the probe, the surgeon cannot find the missile, the case must be left altogether to nature. Should chronic inflammation be developed, as indicated by pain and delirium, and more particularly should abscess form, as indicated by stupor, it might be right to trephine. The pus might thus possibly make its escape, or, by rare good luck, the arrow head itself might be found.

Arrow Wounds of the Face.—Arrow wounds of the face are often attended with considerable hemorrhage, both primary and secondary. They are troublesome, also, on account of the sponginess of the bones, which permits the arrow to penetrate deeply, and then, by allowing the part to close over the head of the missile, opposes obstacles to its extraction.

Fig. 248, from Circular No. 3, S. G. O., 1871, represents a skull in which the arrow entered just above the zygoma, and, passing inwards, penetrated the brain through the temporal region. The shaft of the arrow had been plucked away, leaving the arrow head deeply embedded and entirely hidden in the temporal muscle, and hooked under the zygoma by one of its shoulders, so that its pres-

ence was only conjectured by the surgeon. The specimen shows what difficulty would have attended the extraction of the foreign body, wedged down as it was under the zygoma, at its base, and penetrating into the skull as it did by its point. The specimen and the history of the case are demonstrations of the

Fig. 248.



Arrow wound of temporal bone with entanglement of arrow head by the zygoma. (A. M. M., Sect. 1. Spec. 5907.)

advantages in all cases of thorough digital exploration, not merely to determine the presence of an arrow head, but to enable the surgeon to decide what manœuvre will best serve for its safe removal. In the above case, it would probably have been necessary to resect the zygoma, in order to get enough of the arrow head exposed for the grasp of the forceps. The man survived the injury about a month, and was, during most of this time, without threatening symptoms.

vertebral column—injuries not unlikely to be met with—the case would in all probability end fatally. I have never seen such an occurrence, but it is in tradition that Conrad of Lorraine, having removed his helmet at the moment of victory over the Hungarians, received such a wound, and speedily died.

Arrow Wounds of the Neck.—This part of the body is often wounded, but, as the table on page 109 shows, not with serious effects. Yet if the great vessels should be wounded, or the trachea spiked to the

Arrow Wounds of the Chest.—Arrow wounds penetrating the chest and wounding the *lung*, although serious, are by no means necessarily mortal injuries. The table shows that in 18 such cases, there were 13 deaths, or about 72 per cent. The lung does not collapse after an arrow wound, as it is apt to do after a wound made by a ball, for the arrow shaft is tightly grasped by the cutaneous tissues, and the integrity of the pleural vacuum is preserved. But in this very collapse and contraction lies the patient's safety against bleeding, and hence arrow wounds of the lungs are apt to be attended with internal hemorrhage, which, if at all profuse, leads to almost immediate death by apnœa. If the patient survives the period of hemorrhage, the prognosis is favorable, for the consecutive inflammation is usually trifling, and requires no treatment beyond placing the patient at rest, and affording a supply of pure warm air. If the head of the arrow has been left in the lung tissue, nothing probably can be done for the patient. Only the most superficial examination with the probe is allowable. The patient will probably die with hectic, in the course of six weeks, or, if he survive, will remain an invalid all his life. If the shaft has not been removed, the external wound should be cautiously dilated with bistoury and finger, and the arrow head then snared by the bent loop, or grasped by the arrow forceps, and withdrawn. The loop is the better instrument in these lung cases. The greatest care should be taken not to detach the head from the shaft, for if this should happen, and the head be lost, the patient would almost certainly perish.

If an arrow has passed from one side of the chest to the other, as from the breast to the back, it is better to push it on, and make it emerge through an intercostal space, than to draw it back. If it is lodged in a rib, after traversing the chest from side to side, the point of this lodgment must be ascertained by gently striking the feathered end of the shaft whilst the fingers of

the other hand are passed backwards and forwards over the rib until the point of greatest impact is determined, this, together with the direction in which the shaft points, fixing the position of the head. The rib is then to be trephined at this point. If an *intercostal artery* has been wounded, the application of the actual cautery is the most convenient means for arresting the bleeding: I have used a bent nail, heated, both in intercostal wounds and wounds of the inferior dental artery. Or the whole rib may be encircled by a ligature passed around it with a bent probe, or with a Gibson's aneurismal needle, or with the blunt needle of the chain saw.

An arrow transfixing *both lungs*, or the *heart*, would, if it lodged, necessarily cause immediate death. If it passed out at once, as it sometimes does through the chest of the buffalo, the patient might speedily recover.

In wounds of the chest, if the *pleura* should fill with blood, this should be removed by the aspirator, if possible. If the blood is clotted, it might perhaps be rendered fluid by the injection of a solution of pepsine, as in the case of vesical coagula. Pus in the pleural cavity always requires the use of the aspirator, but empyema is not a common result of arrow wounds.

Arrow Wounds of the Abdomen and Pelvis.—Arrow wounds of the *abdomen* are generally fatal. Not only is there a liability to peritonitis from fecal extravasation, but the wound is apt to be immediately fatal from hemorrhage. But all wounds of the abdominal cavity are not followed by death. The table on page 109 shows two recoveries in twenty cases, a mortality of 90 per cent. In a very interesting case under the care of Surgeon Forwood, U. S. Army, and described in Circular No. 3, S. G. O., 1871, a large calculus which had formed upon an iron arrow head was removed from the *bladder* of an Indian. This man had been shot in the buttock while mounted, and at close range. The shaft of the arrow had been withdrawn, and the head was left behind in the bladder. The man made a good recovery.

The *treatment* of arrow wounds of the abdomen consists in the removal of the missile; the checking of bleeding, by torsion or otherwise; the suturing the intestine, if wounded; the thorough cleansing of the part from excrementitious matters; and the enforcement of rest. An incision should be made sufficiently large to admit the finger, and when the position of the arrow head has been determined, it is to be seized with forceps, and removed. If the shaft has been plucked away, the chance of finding the head is very slight; but the attempt should be nevertheless made, and if fecal matter is found in the cavity of the abdomen, no hesitation should be felt in laying this open and searching thoroughly for the foreign body. Bleeding points should then be twisted, and the intestine, if wounded, sewed up. Very fine carbolized catgut should be employed for this purpose, and it is of comparatively little importance what particular form of suture is used, so that the operation is finished with as short an exposure to the air as possible. The parts, having been cleansed with water containing a little salt and egg serum, are to be carefully returned, and then the incision in the abdominal walls is to be secured by figure-of-eight sutures passing through the muscles as well as through the integument. Opium should be given to stupefaction, and the patient kept under its influence for several days, or until the pulse loses the characteristics of peritoneal inflammation. Any one who has used opium in this way will agree with me, I think, that it possesses, over and above its power of enforcing rest, a specific power of preventing or subduing peritonitis. If any outward application is to be made, I should prefer moist heat, applied by means of large bran poultices. But it must be remembered that, unless frequently renewed, and kept very hot (about 110° F.)—yet not too hot, for the patient, being nearly insensible, may easily be burned—they will

do harm. A trusty and intelligent corps of nurses is indispensable, if heat is to be used in this way. After the primary danger of peritonitis is past, the patient should be kept in the horizontal posture for a month, and fed chiefly on beef, or mutton, or fowl, to which it will be prudent to add some pepsin. Olive oil will keep the bowels in a proper condition.

In concluding the subject of arrow wounds, I would briefly recapitulate as follows:—

- (1) An arrow head must be removed as soon as found.
- (2) In the search for the arrow, extensive incisions are justifiable.
- (3) An arrow may be pushed out as well as plucked out.
- (4) The finger should be used for exploration in preference to a probe.
- (5) Great care must be taken to avoid detachment of the shaft.
- (6) Healing by first intention should be encouraged.
- (7) The surgeon should strive to comfort the patient. Although arrow wounds are not attended with much shock, they are usually the cause of great depression of spirits. "The constitutional disturbances following these wounds . . . are liable to be out of all proportion to the apparent amount of damage. There are almost always considerable . . . sleeplessness and great irritability, dejection of spirits, and intolerance of pain. The tendency to despondency becomes frequently a prominent symptom, to be carefully combated, and everything should be done to cheer the patient."¹

¹ Coues, *loc. cit.*

GUNSHOT WOUNDS.

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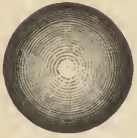
GUNSHOT WOUNDS, as declared by John Bell, are "of most desperate nature, more various than can be imagined, to which all parts of the body are equally exposed." Their frequent occurrence, their danger, and the influence of correct diagnosis and proper treatment upon their progress and result, render the consideration of these injuries of the highest importance to every surgeon, in civil as well as in military practice. Whether produced by small or large shot, by bullet or shell-fragment, or by some one of the much less commonly met with vulnerating bodies (percussion-cap, portion of gun, piece of stone, etc.), directly or indirectly propelled by the explosion of gunpowder, they are, with almost no exceptions, to be classed under the head of lacerated and contused wounds. Their gravity varies according to the importance of the part injured, and to a considerable extent is proportionate to the size and velocity of the missile. Other things being equal, a perforating wound of any part is less dangerous than a penetrating one in which lodgment has taken place, and a large shot, though moving at a low rate of speed (when nevertheless the momentum is great), may produce extensive damage.

MISSILES.

As met with in civil life, these wounds are usually produced by small shot or pistol balls; very occasionally by parts of an exploded piece, by cap, by wadding, by cartridge-shell, or by ramrod. So-called "shot" vary in weight from 133 grains (the largest buck-shot) to as low even as less than one-fifth of a grain (2700 to the ounce), and pistol balls from 25 + grains to 350 grains, of a diameter ranging from .22 up to .50 of an inch. The U. S. service revolver bullet has a diameter of .458 inch and a weight of 230 grains. The heat of the powder explosion may at times fuse a bird-shot charge into a single ball of nodulated exterior. In military surgery, the great majority of wounds result from rifle bullets; quite a number from shell fragments or case-shot balls; some, but not many of those coming under treatment, from solid shot or unexploded shells, and, as in siege operations, from grape-shot. In battles fought in the open country, about nine-tenths of all the wounds received are from bullets—91 per cent. among the Germans in the Franco-German war (Fischer), 94.2 in the Italian campaign of 1859 (Longmore); in siege operations and assaults upon fortifications, the relative proportion of large shot, shell, and grape injuries is, as might naturally be anticipated, very much higher—in the Crimean war about 46 per cent.

With the use of the modern arms of precision, the old-fashioned round balls, of $\frac{3}{4}$ to $1\frac{1}{2}$ oz. weight each (Fig. 249), have almost entirely disappeared as vulnerating bodies, except as secondarily projected by the bursting of case-shots filled with them. The muzzle-loading smooth bore, with the single

Fig. 249.



Round musket ball.

Fig. 250.



Springfield rifle ball.

Fig. 251.



Enfield rifle ball.

Fig. 252.



Ball for Snider gun.

Fig. 253.



Ball for needle-gun.

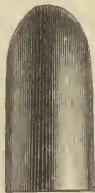
ball or "buck and ball" cartridge, is as much a thing of the past as "brown Bess" herself. The service bullet of to-day, long and generally conoidal (Figs. 250, 251, 252)—egg-shaped in that used with the needle-gun (Fig. 253)—has a diameter of from .41 to .45 inch, and weighs from 315 to 480 grains. The Swiss magazine-gun bullet measures .41 inch, and weighs 315 grains; the Russian .42 inch, 375 grains; the Austrian .425 inch, 318 grains; the French .45 inch, 380 grains; the Bavarian .45 inch, 340 grains; the Prussian .45 inch, 380 grains; the English .45 inch, 480 grains; and that of the United States .458 inch, 405 grains. In the English and American service the bullet is made of hardened lead—13 parts lead, 1 part tin (English); 16 parts lead, 1 part tin (American)—and such bullets may perhaps do less damage than those of soft lead, though it must be remembered that in the experiments that have been made, the diameter of the pure lead Enfield bullet (Fig. 251), was considerably (0.1 inch) greater than that of the hardened one fired from the Martini-Henry rifle (Fig. 257). The Mitrailleuse ball (Fig. 258) weighs about $1\frac{3}{4}$ oz.; the Gatling guns use calibres .45 and .50 small arm ammunition, a "half pound solid elongated projectile," and a one inch

Fig. 254.



Austrian ball.

Fig. 255.



Chassepot (French) ball.

Fig. 256.



Bavarian ball.

Fig. 257.

Martini-Henry (English)
ball.

Fig. 258.

Mitrailleuse
(French) ball.

canister holding 15 buck-shot; the projected Hotchkiss revolving cannon is to throw shells of a little over one pound weight, and case-shot filled with one ounce balls.

From field guns, the sizes of which vary considerably, shell and case-shot are fired, the use of solid shot having been of late abandoned; the cases containing from 41 to 245 or more balls each, of iron in the English service, of

lead in our own. From fixed guns and from the larger guns on shipboard, are thrown both solid and hollow shot, the weight of the single-shot and shell missiles employed ranging from seven to two thousand pounds. If it was true three hundred years ago, as declared by Paré, that a gunshot "going with mighty violence pierces the body like a thunderbolt," how much more so is it now, when a bullet fired from an ordinary Springfield rifle can be driven through 2 inches of pine wood, and from a long-range Springfield rifle through 5 inches of pine at 2500 yards distance; and when a ball from the latter arm is able to pass through 2 inches of pine and penetrate the sand to a depth of 6 inches at a distance of 2 miles (more exactly, 3500 yards).

EFFECTS OF GUNSHOT WOUNDS UPON THE VARIOUS TISSUES.

Before proceeding to the consideration of the results, immediate and secondary, of gunshot wounds, it will be well to notice the general effects which they produce upon the various tissues that may be damaged.

SKIN.—If merely grazed, there will occur either limited erythema with decided pain ("brush-burn"), slight contusion with associated blood-extravasation, or such impairment of vitality as will be followed by the formation of a dry slough. If more fairly struck, there will be either penetration or contusion, according to the velocity and size of the vulnerating body. So great is the elasticity of the integument, that it may yield sufficiently to escape laceration, while there will yet take place extensive extravasation of blood, crushing—even pulpification—of the muscles, and comminution of bone. Such destruction is often produced by large shot, solid or hollow, or a massive fragment of an exploded shell, either passing lightly, but at a high rate of speed, over the surface, or striking only when nearly spent.¹ Not infrequently it happens that a bullet, striking at an oblique angle, pierces the skin, runs underneath it for a greater or less distance, and passes out again, forming what has been denominated a seton-wound, the track of which is often indicated by a line of discoloration upon the surface.

FASCIAE.—In the passage of a shot through the superficial fascia, laceration and contusion occur, not confined to the part actually traversed, but extending for a variable and often considerable distance on either side, there being seldom, if ever, when the wound is inflicted by a round ball, any actual removal of tissue, though a conical bullet carries along with it a greater or less amount of that which it has killed. In piercing the dense external layers of the deep fascia, balls, conical ones particularly, separate somewhat the crossing fibres, so that these fascial openings are of less diameter than the track generally, for which reason they more or less interfere with the subsequent outflow of pus. If of any considerable size, they oftentimes are not filled up in the progress of repair, but their edges cicatrize, leaving a permanent opening through which in after life muscular bulging readily occurs. Oftentimes fascial resistance will be sufficient to deflect the shot, the angle of the line of new direction to that previously travelled varying according to the shape and velocity of the ball, being much greater in the

¹ Macleod, for example, reports that at the Alma, "a round shot 'en ricochet,' struck the scale from an officer's shoulder, and merely grazed his head as it ascended. Death was instantaneous. The scalp was found to be almost uninjured, but so completely smashed was the skull that its fragments rattled within the scalp as if loose in a bag." Under my own observation, an extensive shattering of both bones of the leg resulted from the blow of a large piece of shell, which did not break the skin, the case having been sent in from the field as one of contusion simply.

case of the round than in that of the conical bullet, and being greater when the movement of either form of ball is comparatively slow. The heavy pointed rifle-bullet, fired from a modern rifled musket, is unlikely to have its course much altered; while a pistol ball is frequently turned aside; and a round ball has over and over again been found to "run around" the half or even whole circumference of the body, its rate of speed being relatively low, and its axial rotation favoring the apparently anomalous course.

MUSCLES.—These, when injured, are always considerably lacerated and contused, and infiltrated with extravasated blood; and, when the damage has been done by a large body, it will generally be found to extend through the whole length of the muscle, particularly so if there has been simple contusion without associated open wound. When the entire belly of the muscle has been broken across, marked separation of the divided parts takes place. However, when a portion of a limb has been carried away, as by a round shot, retraction of the torn muscles does not occur, their contractility having been destroyed by the intense force of the blow. So great is the momentum of the small muscular fragments detached by the conical ball in its passage, that they themselves become actual missiles, and often materially add to the damage resulting from the shot. As might naturally be expected, tendons are much more resistant than the fleshy parts of the muscles. They are often pushed out of the way by the passing ball; and even when they must necessarily feel the force of the blow, as from a large shot, they may be protected by the earlier giving way of the muscular bellies. In a case, for example, reported by Gillette, in which there was a very extensive crushing of all the other soft parts from a wound of the leg and foot, the tendons of the extensors, of the *tibialis anticus*, and of the flexors were not involved.

BLOODVESSELS.—These, as has long been known, though lying in the direct path of a ball, are not infrequently pushed aside, and escape all injury—arteries, because of their greater thickness and elasticity, being much more likely than are veins to be thus preserved from harm. Very frequently, however, damage is done; and there will be produced either (1) *complete division*, which is almost certain to occur if the wound has been made by small shot at short range, or by the sharp edge of an angular piece of shell, and which is frequently observed in rifle-ball wounds; (2) the *cutting out* of a piece of the vessel wall; (3) *contusion*, followed by temporary or permanent occlusion of the canal, or by sloughing of the bruised vessel and consequent secondary hemorrhage; or (4) the formation of a *traumatic aneurism*, which may be limited to the artery itself, or may be arterio-venous, if both artery and vein have been involved in the injury. It is possible, also, as shown by a case reported by Lidell, that an aneurism may be developed from the extremity of a completely divided artery.

NERVES.—Much less often than bloodvessels are nerves found to have safely glided away from the vulnerating body, their more usually observed injuries being division, complete or partial, contusion, and concussion. Occasionally small foreign bodies (such as splinters of wood or pieces of lead) become lodged in a nerve, causing either little or no inconvenience, or, as is more common, severe and persistent neuralgia. Impairment or entire loss of motion or sensation; pain of varying degree and duration, at times burning (the *causalgia* of Mitchell); trophic changes, or absolute destruction of the vitality of the parts supplied, are the results of these nerve injuries.

BONES.—The violent impact of a ball or piece of shell will produce either contusion or fracture. The fracture is very rarely simple, though such an accident may result from the blow of a piece of wood, or iron, or stone, set in motion by a gunshot projectile which has struck it. It is ordinarily comminuted, frequently extensively so, though there may be (rarely it is true) penetration or perforation without shattering. The contusion may be so slight as to cause little or no damage; so severe as to at once destroy the life of the part struck; or, as generally happens, sufficient to light up destructive inflammation. Penetration and lodgment of the missile may occur; the bullet, if not removed, either becoming encapsulated, or, as is generally the case, causing inflammation and suppuration, and being often, months or years afterwards, found lying loose in an abscess cavity. When it is a long bone that has been pierced, the shot or a part of it may, as in a case reported by Surgeon-general Murray of the British Army, drop down in the medullary cavity, and, by its presence, keep up an osteomyelitis of low grade.

DIAGNOSIS OF GUNSHOT WOUNDS.

That a gunshot wound has been received, is generally determined by the history of the case and the observation of an abnormal opening or openings upon the surface of the body. Very seldom does it happen, except in attempts at suicide, that the bullet enters by a natural orifice, though it may do so.¹ Ordinarily, the points to be decided are: (1) Whether or not penetration and lodgment have occurred; (2) What course the ball has taken; and (3) Whether the discovered multiple wounds are due to a single shot or to several.

At first sight it would seem to be a very simple matter to determine that a bullet had lodged, a single opening only being found. But it may already have been removed, or it may have rebounded, as happens at times when the skull or other comparatively superficial bone has been struck, owing to the elasticity—not of the lead—but of the osseous tissue; or, what not infrequently happens in cases of spent balls, particularly round ones, it may have been drawn out by the clothing, a part of which, uncut, had been carried like a glove finger over and in front of it. Inspection should always be made, therefore, of the clothing that covered the wounded part.

Much more difficult is it oftentimes to know in what direction the ball has passed, and where it has stopped. The clothing is to be examined, and the position noted of the openings in the various layers, relatively to each other and to the skin wound. The body is to be placed as nearly as possible in the same position as when struck, if this can be determined; a rule of practice as old as the time of Paré. The direction in which the shot was fired, if known, must be taken into consideration. By use of the probe, or better, the finger, the track is to be followed, as far as possible, or until penetration of one of the great cavities is ascertained. A conical bullet, moving at full speed, ordinarily passes straight from the point of entrance to the place of lodgment, if it does not, as it is likely to do, pass through and out; but it is a mistake to declare, as has been done by many, that deflection cannot take place. Fasciæ, and still more bone, will at times turn the bullet aside. Pistol balls are not infrequently thus affected. I have seen, for instance, a case in which the shot, entering the right temple, passed through the anterior lobes

¹ This was instanced in the case of a distinguished general officer during our late war, who was killed by a shot that passed in through the anus. Gillette reports, on the authority of a M. Boissinon, a hardly credible story of a French officer who was shot in the face, the ball entering through the anterior nares, passing back and striking the posterior pharyngeal walls, and rebounding through the mouth.

of the brain, struck the skull on the left side, and was turned almost at a right angle to its previous course, and lodged in the left posterior lobe. The old-time round ball was very apt to glance and pursue an erratic way, at times making a complete circuit of the body, and emerging through the entrance wound. A spherical shot of considerable size may be turned aside; thus Otis reports a case in which a "one and a quarter inch grape, from a battery about three hundred yards distance, was deflected on striking the hyoid bone, and buried itself in the muscles over the right shoulder-blade."

Even when the direction has been determined and the track followed, it may not be easy to ascertain the location of the ball. It may be masked by a piece of cloth (and nothing but the finger will, as a rule, recognize the presence of such), or it may be a question whether the probe is in contact with ball or bone; a question that of late years has ordinarily been settled by the employment of the "Nélaton probe" (Fig. 259), the unglazed porcelain tip of

Fig. 259.



Nélaton's bullet probe.

which will take a slight bluish stain when rubbed or pressed upon lead. (Having once taken such a stain, however, it is likely to ever after retain it, so that practically a fresh instrument will be required for each new case that is to be examined.) In default of a probe, a clean clay pipestem,¹ or a piece of soft pine may be advantageously used as a searcher. At times it may be practicable to pass in a pair of cutting forceps, and bite off a small piece of the body, examination of which will reveal its metallic or other nature. Various electrical appliances have been used: either probes to be carried along the track of the wound—contact with the metallic foreign body causing the ringing of an attached bell, or deflection of a galvanometer; or needles thrust through the overlying tissues and made to touch the supposed ball, and, by the establishment of a circuit, act on an annunciator or galvanometer; or surface electrodes, which in passing the current through the lead, will cause pain, burning, tingling, and perhaps shock. Thus far the use of electricity in enabling the surgeon to recognize the existence and location of a ball, has been but limited, and, in the main, unsatisfactory in its results. Of such chemical methods as that of Deneux, who suggested the use of a weak acid, either upon an exploring instrument or injected through the track, it may be well said that "though they are ingenious, they are too delicate and too uncertain to be of any great service in Military Surgery." (Rochard.) Where no positive evidence of the location of the projectile can be obtained, either by exploration of the wound or by palpation of the area of the skin towards which it must have passed, its position in a particular part is often rendered very probable by the localized pain which is experienced, by the swelling which, after a few days, is developed, and by the decided interference with the making of certain movements which is recognized.

WOUNDS OF ENTRANCE AND EXIT.

Speaking generally, the entrance wound is smaller than that of exit; but under certain circumstances, and at certain times, the reverse is found to be

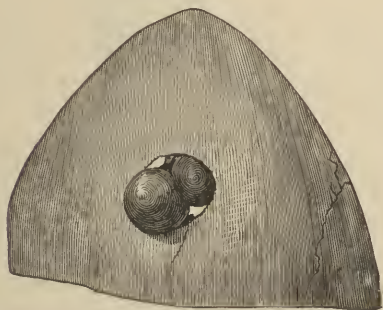
¹ Legouest, ten years ago, reported that he was in the habit of using the clay pipestem, and Highway employed it during our late war with Mexico, twenty-five years earlier.

true. The differences in this respect that have not infrequently been noticed, and the resulting, conflicting views of observers and writers, may be easily understood and readily explained. It is a well-known law that splintering and tearing are in inverse proportion to momentum, and according as the velocity of a missile is lessened in passing through a portion of the body, will the orifice of outlet present greater size than that of inlet. This diminution of force being much more in the case of a spherical than in that of a conical ball, wounds produced by the former will show correspondingly greater differences in size than those produced by the latter; indeed, oftentimes, a pointed bullet, moving at a high rate of speed, will in its perforation make skin openings that cannot by their size alone be distinguished the one from the other. Again, if the point of entrance is over a surface of bone but a little beneath the skin, as, for instance, on the chin or over a rib, and especially if the shot has been fired at short range, the extent of laceration will be very great; and on the other hand, if the ball in its course shatters a bone just before going out, or carries along with it a quantity of crushed and separated tissue, the amount of skin-tearing will be much in excess of that which otherwise would have occurred.

The size of the primary wound will also be decidedly affected by the obliquity of the angle of entrance, a large degree of which will cause raising of the skin and consequent bevelling of the orifice. After a few days, when separation of the slough has taken place, the entrance wound will usually be as large or larger than that of exit, especially when the injury has been caused by the passage of a round ball. When the shot has been fired at very close range, and has struck an uncovered part of the body, the entrance wound may often be recognized by the powder staining around about it, though such evidence is not as likely to be had at the present time as formerly, since the modern improved powder is so much more thoroughly burned up at the time of its explosion.

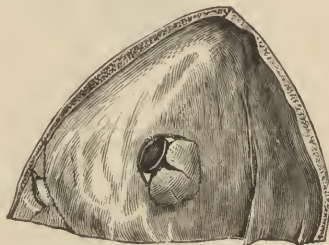
MULTIPLE WOUNDS are often met with, and may be due to several shots or to a single one. When to several, these may all have been inflicted at once—as from the bursting of a shell or of a “spherical case,” or from volley firing—or they may have been received at different times; and when due to a single shot, they may be consequent upon the repeated passing in and out of the same ball, as in traversing both upper and lower extremities, or the forearm,

Fig. 260.



Section of frontal bone with split musket ball impacted at left frontal eminence. (A. M. M., Spec 1293.)

Fig. 261.



Interior view of frontal bone represented in Fig. 260.

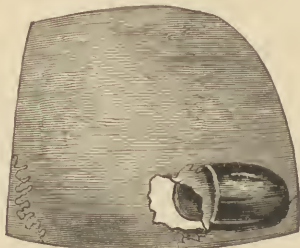
arm, and chest, or may depend upon the splitting of the bullet, either before entering the body, or by contact with a ridge or edge of bone. Not infrequently, the fact that the existing three, four, or more wounds are due to the same shot, can be ascertained only by placing the several parts of the body in

similar position to that held at the time of the injury, and by seeing that the various openings are then all in line; and even this study of position will not always answer, for there may have been deflection of the ball at some point of its course. That bullets, particularly round ones, are occasionally split, either in passing into or through the body, every one knows, and such division may be complete or partial.

In a case under my care, a round musket ball that struck and fractured the frontal bone was so far split as that one part passed into the opening in the bone, while the other rested on the external surface, a narrow bridge uniting the halves. (Figs. 260, 261.)

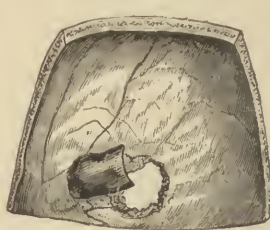
Conical rifle bullets are much less likely to be thus affected, but abundant evidence has accumulated to prove the incorrectness of Macleod's belief that "with their immense force of propulsion they cannot be split." (See Figs. 262, 263.) Pistol balls, elongated though they are, are every now and then divided.

Fig. 262.



Section of right parietal bone on which a conoidal musket ball has split. (A. M. M., Sect. 1, Spec. 2121.)

Fig. 263.



Interior view of parietal bone represented in Fig. 262.

Quite recently I saw, post mortem, that one of these missiles, after boring through the head and neck of the humerus, had, in striking the edge of the glenoid cavity,

Fig. 264.



Head and neck of humerus perforated by a pistol ball which was smoothly cut in two upon striking the scapula. (See Fig. 265.)

Fig. 265.



Pistol ball split by striking upon bone. (See Fig. 264.)

been smoothly cut in two, one half lodging in the supra-spinous and the other in the infra-spinous fossa (Figs. 264, 265). Had in this case the propulsive power been a

little greater, these pieces would have been driven out, and there would have been three wounds, one of entrance and two of exit.

Much more rarely than multiple openings from a single shot, has there been noticed a single wound from two projectiles, a condition of things that has been recognized only upon removal of the bullets, or from the persistence of discharge and non-closure of the track after one ball has been extracted.

EFFECTS OF GUNSHOT WOUNDS.

The general effects of gunshot wounds may be classed under two heads, *primary* and *secondary*. The former are consequent upon nervous and vascular disturbances, and are pain, hemorrhage, and shock.

PAIN is exceedingly variable in character and amount, depending upon the shape and velocity of the shot, the part struck, the constitutional susceptibility of the subject, and the special mental condition at the time. Occasionally acute, it is more often dull and tingling, a sensation of contusion as if from the blow of a stick, the degree of the pain, speaking generally, being in inverse ratio to the velocity of the shot. It may not be felt at all: ordinarily because the shot has been received at a time when the individual was under strong excitement, but not necessarily so, as instanced, for example, in the case of wound through both hemispheres of the brain reported by Harvey.

The patient, who was seated in a buggy at the time of the accident, experienced no pain and felt no blow on the reception of the injury, but remarked to a gentleman who occupied the buggy with him, that one of their guns must have gone off prematurely, as he judged from a sensation similar to that produced by the report and concussion of a shot fired near the ear.¹

When large nerves or nerve cords are divided, there may be immediately experienced a severe pain, lasting ordinarily but a few moments, but in numerous cases little or no suffering is caused.

HEMORRHAGE, too, is very variable in amount, being affected by the size of the vessel, the extent to which this is damaged, and the nature of the vulnerating body. Wounds of the main trunks, if made by large bullets or angular shell-fragments, are very generally followed by immediate and fatal bleeding. To such we are undoubtedly justified in attributing many of the deaths in action, though it is impossible to estimate the proportion of mortality due to this cause with any degree of accuracy, owing to the small number of battle-field examinations that have been made. The French reports from the Crimea place it at 18 per cent., a figure certainly none too high. Lidell has shown that hemorrhage was evidently the cause of death of nearly one-half of the forty-three soldiers whose bodies he examined after an engagement in front of Petersburg; and that of the remaining half, most were shot in the head.

But while they are of the gravest character, these wounds of the great vessels are not necessarily at once mortal. The aorta itself has been penetrated by a round ball, and life preserved for days and even for weeks. During our late war, cases were treated in hospital in which the vertebral, carotid, subclavian, axillary, and common iliac arteries, and internal jugular, internal iliac, and femoral veins were divided, as was proven by post-mortem exami-

¹ Asst. Surg. P. F. Harvey, U. S. A., in American Journal of the Medical Sciences, July, 1879.
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nation. I have myself seen a patient live for ten hours after a pistol ball had passed through the superficial femoral and profunda arteries and the femoral vein; and another in whom death did not occur until the eleventh day, though the pistol ball had cut the left subclavian. Ordinarily, the primary hemorrhage, aside from the first gush, which may or may not be considerable, is but slight, so much so that it has often, though incorrectly, been declared that "gunshot wounds do not bleed." The explanation of this is, of course, to be found in the contused character of the wound of the vessel—contraction, retraction, curling up of the divided inner coats, and coagulation, all combining to close up the orifice. At a later period in the progress of these cases, secondary hemorrhage is very likely to occur, and is often followed by a fatal issue.

SHOCK.—This nervous disturbance, of the intimate nature of which little or nothing is known, but which for the present may be assumed to concern chiefly the ganglionic system, is in some degree or other an almost constant accompaniment of gunshot wounds. This "reflex effect of the injury of nerves, large or small" (Mitchell), is indicated by enfeeblement of the heart's action, and occasionally disturbance of its rhythm; by resulting pallor, especially of the face, with clamminess of the skin, and at times decided and great reduction of temperature; by nausea and vomiting; by relaxation of the sphincters; by mental irritability, amounting it may be to delirium; and by more or less complete loss of consciousness. These reflex phenomena are very often markedly aggravated by the effect of fright on the one hand, and of hemorrhage on the other, so much so that in a given case it may be difficult, indeed impossible, to properly apportion the observed symptoms to these simultaneously acting causes. The nearer the wound is to the three great centres—those of intellection, of circulation, and of digestion—the greater, other things being equal, is the degree of shock produced, the greatest being, as a rule, noticed when the intra-peritoneal viscera are damaged, as might naturally be expected from the intimate nervous connection which these all possess with the semilunar ganglion, "the abdominal brain." From the earliest times, surgeons have laid it down as a law that severity of shock is proportionate to, and consequently indicative of, the gravity of the injury; and this is undoubtedly true, though the original constitution of the individual and his special mental state at the time of the wound (as regards fear, excitement, drunkenness, etc.) exercise a great influence upon the degree of development of this condition. In a diagnostic point of view, the most important symptom of shock is reduction of temperature.

Redard, as the result of careful observation of fifty cases in Paris, declares that "In gunshot wounds, a fall of temperature is a constant phenomenon. . . . Every wounded man brought to field hospital presenting a temperature lower than 35.5°C . (about 96°F .) will succumb, and consequently it is useless in such cases to resort to any operation. Every wounded man in whom a salutary reaction does not come on by the end of the fourth hour, and in whom the reaction is not in direct proportion to the fall [of temperature previously], ought to be considered as in a very serious state. Penetrating wounds of the abdomen produce an exceptionally low fall of temperature, which is more marked as the stomach is approached. . . . Wounds by shell, other things being equal, produce a more marked fall of temperature than those by ball."

SECONDARY EFFECTS.—*The secondary effects* are those of inflammation, the degree of which will be very materially affected by the condition of the subject, the location of the wound, the size of the shot, and the treatment employed. Although at times flesh wounds, especially those made by single bird-shot and small pistol balls, are quickly recovered from, and the healing

is accompanied with very little local disturbance—so little that practically the repair is by first intention—yet, in the great majority of cases, gunshot wounds follow the ordinary course of lacerated and contused injuries. The devitalized tissue along the track is thrown off, suppuration occurs, granulations are developed, adhesions take place, and the external wounds in due time cicatrize. The inflammation which attends the reparative process is early set up, frequently within a few hours—six or eight—almost certainly within twenty-four, and in simple cases presents nothing peculiar. In the severer injuries, as those in which a bone is damaged, both the local and constitutional symptoms are much graver, and there is a strong probability of the development of one or more of the several complications to which reference will presently be made. In proportion as the patient is in good health, receives prompt attention, and is kept quiet, is the probability of but a moderate degree of inflammation resulting; and, on the other hand, when, as is so often the case in time of war, the constitution is already enfeebled by excesses, over-work, or disease—the wound is for hours, perhaps days, neglected—and the patient has been jolted for miles over rough roads—even the simplest of flesh wounds may be attended by local and general disturbances of high grade.

COMPLICATIONS OF GUNSHOT WOUNDS.

Of much greater importance, because of their much greater danger to life, are the not necessary, but frequently occurring, complications of inflammation and results of wounds: secondary hemorrhage, septicæmia and pyæmia, gangrene, erysipelas, and tetanus.

SECONDARY HEMORRHAGE.—Though, as we have already seen, severe primary bleeding is of comparatively infrequent occurrence in the cases of gunshot wound coming under treatment, a later hemorrhage very often takes place, and contributes largely to the fatality of such injuries. This bleeding may come on within a few hours after reaction has been established (when it is simply “delayed,” and not properly “secondary”), or, which is much more common, after the expiration of several days or even weeks; complete certainty of its non-occurrence being only secured by the entire healing of the wound. In the great majority of cases, secondary hemorrhage depends either upon the separation of an originally contused portion of the vessel-wall, or upon the melting down of an artery and of its plugging coagulum, in the midst of an inflamed and suppurating area. In the former case, it is most likely to come on during the second week, and probably the first half of it; and in the latter, somewhat later, quite generally from the fifteenth to the twenty-first day. The first hemorrhage is usually very profuse, when the artery is opened by the detachment of a slough, and may be so when due to ulceration, though frequently in such a case it is primarily but slight, but soon recurs in larger and perhaps fatal amount.

The blood may almost wholly escape externally, or may be chiefly poured out into the surrounding tissues; or there may be both extensive infiltration and large discharge from the wound. The accident may come on without any special exciting cause; or may be due to injudicious movements—as, for instance, of a limb in which a sharp edge of bone has been for days fretting away the arterial coats, or in which a bone fragment is thrust against an already softened vessel—or of the whole body, as when the patient makes an unwonted exertion, as in jumping out of bed; may result from sudden disturbance of the circulation from mental excitement, as from anger; or, which

is a very frequent cause, may follow upon violent straining, as at stool. Cachectic conditions, especially scurvy and chronic diarrhœa, and the very much more rarely met with peculiar constitutional predisposition of "bleeders," render the occurrence of hemorrhage after the receipt of a wound much more likely. However produced, secondary hemorrhage may quickly end the life of the patient, as it is very apt to do if the artery is above medium calibre; or recurring again and again, by the resulting prostration and mental depression, it may more slowly, but none the less surely, bring about a fatal result.

SEPTICÆMIA AND PYÆMIA.—To "blood-poisoning," especially in military practice, is due in a great measure the mortality of gunshot wounds not necessarily and speedily fatal. Consequent, probably, upon the absorption of an organic, septic material, developed in the injured tissues, it may manifest itself by phenomena due to the circulation of blood unfit for nutrition, the nervous system being thereby profoundly impressed (*septicæmia*); or by the formation of visceral metastatic abscesses, chiefly in the lungs and liver (*pyæmia*). Occasionally both conditions exist together. The poison, whatever it may be, is ordinarily formed in connection with an open wound, either produced by the shot or by subsequent operation; but is at times generated in the damaged tissues of a contusion. The lymphatics are its chief primary carriers in the septicæmic cases, the veins in the pyæmic. In the former, the symptoms are ordinarily developed at an early period, sometimes within the first thirty-six hours; in the latter, they do not appear until after suppuration has been established. Diffused metastatic inflammations, with resulting suppurations, are met with in both forms of blood-poisoning, but more commonly in the pyæmic; and such inflammations attack by preference the larger joints and the superficial fascia, and occasionally the viscera and glands. The circumscribed, multiple abscesses of the lungs, liver, spleen, kidneys, or brain, are due to embolic infarctions, the emboli being not simple, but septic, and the poisonous impress having been made upon them while they were still component parts of the primary venous thrombus.

Whether or not external aerial organisms are the exciting causes of the poison-generating changes that take place upon and in the immediate vicinity of an open wound, is still a question. That the poison once generated can be transferred from one wounded man to another by sponges, by dressings, by attendants, or by currents of air, admits of no doubt. Nor can it be denied that everything that tends to lower the general tone of the system renders an individual more likely to suffer from septic disease. Malarial affections, scurvy, forced marches, insufficient and improper food, excesses, the depression of defeat, captivity, with its frequently associated overcrowding—each and all have contributed much to the predisposing of wounded soldiers to outbreaks of this bane of military surgery, that at times becomes, as it was in the late siege of Paris, a "hideous scourge."

Symptoms of Pyæmia and Septicæmia.—Though these two affections have in their symptoms much in common, yet they present sufficient differences to permit ordinarily the ready establishment of a differential diagnosis. Both are marked by rapidly developed high *fever*, with great, irregular, and quickly recurring (almost always daily) variations of temperature, the thermometer indicating a body-heat at one time as low as normal, at another as high as 104°, or 106°, or even 107° F.—higher as a rule in septicæmia than in pyæmia. The *pulse* is feeble, and generally rapid, though there is not of necessity the ordinarily observed relationship between pulse-rate and temperature. Profuse *sweatings* occur, especially in pyæmia; *diarrhœa* is often present; and the *breath* acquires a peculiar and characteristic odor. Little or no *pain* is

experienced; *mental hebetude* is generally well marked; a low muttering *delirium* is very frequently present, and, much more rarely, an active maniacal state. As we have already seen, septicæmia may set in at any time, pyæmia only after suppuration has occurred.

Septicæmia is very seldom ushered in with a *chill*, and, when it is, never has more than the initial one; pyæmia always commences with a chill, and subsequent rigors, occurring at irregular intervals, are very rarely absent. The *skin* in septicæmia is pale and sometimes muddy; in pyæmia it is jaundiced, often deeply so, though the discoloration may be noticed chiefly, perhaps only, in the conjunctiva. In septicæmia, *visceral inflammations* are not commonly present; in pyæmia, pleurisy and pneumonia, or hepatitis, are lighted up around the abscesses, though frequently these occasion comparatively little distress. A septicæmic *parotitis* has not infrequently been observed, and in most instances in which it has been seen, the case has terminated fatally. The pyæmic *joint suppurations*, and abscesses in the superficial fasciæ, are very rapidly developed, and frequently give rise to no subjective symptoms whatever. The attending *wound*, if suppuration has become established, usually becomes dry, the granulations are pale and withered, and what pus there is, is often fetid, though at times little or no change in appearance or secretion is observed.

Prognosis.—The fatality of acute blood-poisoning is extreme; and every one who has seen much of it will be almost if not altogether ready to declare, with Mr. Longmore, that it is doubtful whether in military surgery it is ever, when thoroughly manifested, “checked in its deadly advance.” In civil life, recoveries occasionally take place. Death may, particularly in septicæmia, occur within twenty-four hours, but usually the patient lives from four days to a week. Subacute and chronic cases much more often terminate favorably, though even in these the percentage of deaths is high, especially in the chronic variety, in which very often, after weeks of little or no apparent change in the symptoms, as indicated by pulse and temperature, the patient finally succumbs to the slowly but surely progressing prostration.

GANGRENE.—Consequent upon, or at least associated with, gunshot wounds, both *traumatic* and *hospital gangrene* are met with; the former frequently, the latter rarely, and then, usually, occurring as a local epidemic.

Traumatic Gangrene.—The ordinary traumatic gangrene of military surgery is of the moist variety, and may depend upon one or other of several causes. Very occasionally, the death of a part is immediate upon the receipt of the blow—for it is usually due to contusion by large shot—both bloodvessels and nerves being functionally, if not actually, destroyed at once. The color of the skin is at first unchanged, or whiter than normal; arterial pulsations are absent, and the local temperature is much and rapidly lowered. Again, after the receipt of a bullet wound, apparently of no special severity, pain may, in the course of a few hours, be experienced in the injured part, followed by rapidly forming great swelling, lividity of the skin, and gaseous distension, with constitutional symptoms of high grade—an intense typhoid condition being often developed before death, which takes place generally within twenty-four hours.¹ The development of such “*gangrène foudroyante*,” asso-

¹ As an example of speedy death, may be cited Gillette's case, in which, on the fourth day after the receipt of a shell wound of the forearm, “in the morning, the whole left upper extremity, from the hand to the clavicle, was found to be extremely swollen, the skin as tense as a drum-head, presenting in places a violet-blue discoloration with blebs. Emphysematous crackling could be felt all over the limb. In spite of numerous incisions, the patient died in the middle of the day.”

ciated with open wound, has of late been generally attributed to the influence of septic bacteria, but by Wyatt (who saw it in Paris during the siege) it is declared, though incorrectly, to be confined to the lower extremity, and to always indicate division of the sciatic nerve.

The great majority of cases of gangrene are consequent upon interference with either the inflow or outflow of blood in the wounded part, or below it; and such interference with the circulation may be caused by inflammation, by blood infiltration, by the plugging or ligation of the main vessels, or, occasionally, by the constriction of badly applied dressings. In inflammation, there is both stasis in the vessels of the affected area, and pressure exerted by the effusion and exudation upon the arteries and veins of the adjacent parts; in the hemorrhagic infiltrations, there is like pressure exerted by the extravasated blood, which may be in a single mass of considerable size, from tearing of a large vessel or vessels, or in many small collections from the general laceration that is always found extending some distance on either side of the wound. Very generally these two causes, in varying relative proportion, are found acting together.

The gangrene thus produced presents the ordinary symptoms which characterize it when resulting from traumatism other than gunshot, the pain, the after insensibility, the coldness, the color changes, and the tendency (stronger or weaker, according to the extent of the damage and the general condition of the patient) to the formation of a line of demarcation and spontaneous separation of the dead tissue. When the chief artery or vein, or both, of a limb have been contused, their closure is very apt to occur, either from the pressure of blood from the ruptured vasa vasorum, extravasated between the sheath and the vessel, or, much more probably, from the formation of a thrombus; sometimes, perhaps, from inflammatory stenosis. The resulting mortification begins at a distance, and usually, if left to itself, advances steadily and rapidly up the limb, with not even an attempt at the establishment of a line of demarcation, and speedily causes death. In such a case, following a wound from side to side through the popliteal space, I saw the whole limb become gangrenous, and the patient die in less than thirty-six hours after the first symptoms manifested themselves in the foot. When the cause is not plugging, but ligation of the main artery, though there may be a similar uninterrupted extension of the mortification, spontaneous arrestation not infrequently occurs; just below the knee, for example, when the femoral or popliteal is the trunk that has been tied, the vitality of the parts above being maintained by the blood carried through the profunda.

The fatal result in these cases of gangrene is usually due to blood-poisoning—either septicæmic, from absorption of the fluids from the dead and dying parts, or pyæmic, from the formation of thrombi and their subsequent destruction—though when death occurs suddenly, as it does at times, it may be, as maintained by Parise, because of the entrance into the heart of the gases of decomposition, which produce results the same as those that follow the admission of atmospheric air through veins divided in an operation.

Hospital Gangrene.—This, unlike ordinary gangrene, is not an effect—a death in mass from injury of nerves, or more generally of vessels—but is a disease which manifests its presence by tissue destruction of greater or less extent. Occasionally occurring sporadically, and in private practice, in the great majority of cases it is met with in hospitals, where large numbers of wounded are aggregated. Any wound, even the smallest, may suffice for its starting point, but it does not commence on an unbroken surface; shell wounds are said to be particularly likely to be attacked by it. Regarded by some as

primarily a constitutional affection, it is believed by most to be of local origin, the general symptoms occurring only secondarily, and sometimes being absent altogether. Attacking more often those broken down by dissipation, overwork and over-worry, scurvy, diarrhœa, or malaria, it yet may seize upon the strongest and the healthiest. It cannot depend upon weather or place, since it has prevailed at all seasons and under the most diverse climatic and atmospheric conditions. Many of the Germans have seen in it but a wound diphtheria; but by surgeons generally the two diseases are regarded as separate both as regards etiology and symptoms, though both are characterized by the deposit of fibrinous infiltration on the affected tissues. Believed by some to depend upon the presence of a special organism, none of the more competent observers have been able to discover in its discharges anything else than the ordinary bacteria of putrefaction. Heme's statement is still a true one, that its cause is "a specific poison of unknown nature, which exerts its action upon the surface of the wound and produces a coagulation of the fluids, passing step by step through the superficial to the deeper parts."

That hospital gangrene is both contagious and infectious, is certain, and when prevailing epidemically, its direct transmission from patient to patient may generally be easily shown. Three varieties are met with—the ulcerative, the pulpy, and the gangrenous—the two latter being very often, if not generally, associated.

The *ulcerative* is the rarer and the milder form; the others are more common, and are always attended by general disturbances, often of great intensity. Locally, the ulcerative form shows "a small cup-shaped excavation, with raised edges of a deeper color than the rest of the wound, filled with a brownish tenacious ichor. Many of these ulcers may be simultaneously developed on the same wound; extending superficially and in depth, they destroy the granulations, and give rise to an abundant secretion of an ichorous fluid. The fusion of a number of ulcers accelerates the progress of the disease that soon affects the entire wound, the suppuration of which is arrested, and in place of the pus, there is poured out a fetid liquid, colored dark by blood." (Legouest.)

In the *pulpy* variety, which may be the primary form, or may be consecutive to the ulcerative, there are developed "false membranes, firmly adherent, covering a part or the whole of the wound. This semi-concrete material of a dirty grayish-white color, with blackish points as it were sprinkled over it, exactly covers the invaded parts; it steadily and rapidly increases in thickness and consistence, then softens down, and becomes converted into a violet-gray putrilage, horribly fetid, that partially or completely falls off, leaving underneath sometimes an ulcerated surface, sometimes a layer of material that afterwards goes through the same changes." (Legouest.)

The *gangrenous* variety attacks usually "recent wounds and stumps. The whole injured surface is covered with a layer of material that presents the appearance of moist gangrene, in which are found numerous particles of dead cellular tissue, with disseminated small blood clots of grayish, brown, or greenish color, and from which there exudes a grayish and very fetid fluid. The gangrenous layer is thrown off in mass, or in pieces of some size, on the third or fourth day; dead masses, made up chiefly of the connective tissue, are drawn out in pieces of greater or less size from the muscular interspaces and the subcutaneous layers. The skin over the affected part is of a wine-lees redness, thinned at certain points, and softened at others where fluctuation is present. The detachment of the sloughs sometimes exposes a new pseudo-membranous layer; more often it leaves uncovered the tissues, which show themselves of a pale rose color, and which secrete a sero-purulent liquid of bad odor." (Legouest.)

Hæmorrhage not infrequently occurs in hospital gangrene, especially when the exudations are colloid in character, and if of considerable amount, the bleeding forms so important a feature of the case that some writers have described a special variety of the disease—the *hæmorrhagic*.

Hospital gangrene has an incubative stage of uncertain length, shorter in proportion to the after-severity of the attack. During this stage the wound ordinarily becomes dry, and the granulations perhaps œdematous, perhaps very vascular and irritable. Pain is always present from the start, and is usually a very important symptom, becoming not infrequently excruciating. High fever of typhoid character attends the severer and more acute cases. The temperature of the affected part is often but little elevated. The extent of the local destruction varies with the character of the attack, the condition of the patient, and the nature and thoroughness of the treatment. The connective tissues and the muscles rapidly melt down, while the tendons and ligaments resist for a considerable time. The larger nerves and blood-vessels do not readily yield, and have not infrequently been observed for days bridging over a chasm made by the destruction of muscles and fasciæ; and oftentimes they escape altogether. In the worst cases, even the cartilages and bones are eaten up, and Ollivier reports that he has seen a whole extremity destroyed within 48 hours. The milder attacks may spontaneously terminate in recovery, but usually a favorable result is secured only by proper treatment. The severer cases judiciously cared for are ordinarily cured in fair proportion, though in certain epidemics the mortality has been enormous, as high even as 80 per cent. Death, when it occurs, may be due to erysipelas (which has been known to attack one-third of the cases), to hæmorrhage, to pyæmia, or to septicæmia.

Not so very seldom, the disease has been seen affecting one wound on a patient's body, while another on the same person remained unattacked. Thus Thomson has reported a case of simultaneous wound of both thighs, in which, "whilst the gangrene was ravaging the left thigh, the rapid cicatrization of the right proceeded uninterrupted." How is such a condition of things reconcilable with the theory of a constitutional origin of the disease?

ERYSIPELAS.—This affection is frequently seen associated with gunshot as with other wounds, occurring both in the simple and in the phlegmonous variety, and presenting its ordinary phenomena. The simple *cutaneous* form of the disease may appear early, but is often not developed until the healing of the wound is well advanced. When occurring in comparatively healthy subjects, it adds but little to the gravity of the case, merely, as a rule, delaying recovery.

Phlegmonous Erysipelas (which oftentimes affects primarily the subcutaneous connective tissue, and only secondarily involves the skin) is, on the other hand, a very serious complication, causing extensive destruction of tissue, and being, in a considerable proportion of cases, followed by death from exhaustion, or, more often, from blood-poisoning. Consequent upon either the influence of outside organisms or septic material developed in the dead and dying tissues of the wound, phlegmonous erysipelas is commonly a hospital affection, highly contagious and infectious, which may attack its subject early or late after the receipt of the injury. More likely of course to seize upon the weak and debilitated, its victims are often among the strongest and healthiest.

TETANUS.—This most fatal of all the complications of gunshot injuries is, fortunately, of comparatively rare occurrence. Its cause is unknown. Usually regarded as consequent upon nerve injury, its symptoms being developed either

by reflex irritation or by induced pathological changes in the spinal cord, it is believed by many to be the result of a peculiar form of blood-poisoning, and by others is thought to be due simply to atmospheric conditions. Tetanus is very seldom met with in connection with wounds of large nerve trunks, but is generally associated with lacerations of the peripheral filaments, especially in regions in which the Pacinian corpuscles are most abundant. It may manifest itself at any season of the year, but more frequently when there is a marked difference of temperature between midday and midnight,¹ or when cold, wet weather follows a warm, dry spell. Prolonged high heat, as in tropical climates, unquestionably predisposes to tetanus, or at least favors its development. It seems to be of rarer occurrence among the wounded of modern wars than it was formerly, because, as may be properly assumed, gunshot injuries are now less irritated, and are better cared for than in previous times. Usually acute, and almost certainly fatal, it may be of milder character, of more prolonged duration, and of proportionately less mortality. Its action may be confined to a few muscles, those of the jaw being usually affected (*trismus*), or may be more widely exerted, producing in the great majority of cases a backward bending of the body (*opisthotonos*). Larrey's opinion that the direction of the arching depended upon the location of the wound—on the back, front, or side—is believed by few, if any, of the surgeons of the present day to be correct. Death usually occurs within a few days; in half or more of the whole number of cases, within the first five.

PROGNOSIS OF GUNSHOT WOUNDS.

This must, of course, depend upon the nature and location of the wound; upon the treatment adopted, and upon whether it is instituted promptly or not; upon the hygienic surroundings of the patient; and upon his general condition before and at the time of the reception of the injury. Other things being equal, the patient's chances of recovery are better in civil than in military life, for, as Sir W. MacCormac has very truly said, the danger of gunshot wounds "often arises more from external circumstances—overcrowding, want of after-care, long transport—than from the nature of the injury itself." Taking large numbers of wounded together, the mortality of cases coming under treatment is from 10 to 15 per cent.; but such a statistical statement is of little or no value, since the probability of recovery in any given case depends upon its particular circumstances.

TREATMENT OF GUNSHOT WOUNDS.

This consists in clearing the wound from foreign bodies; combating, as far as may be, the primary effects (pain, shock, hemorrhage); moderating the resulting inflammation; and meeting such secondary complications as may arise.

REMOVAL OF FOREIGN BODIES.—From the earliest times, "immediate exploration" has been the rule, to the end that any foreign bodies which have

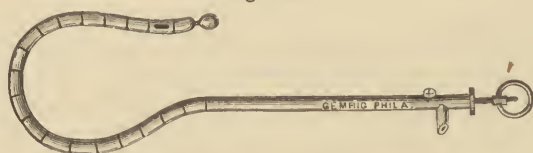
¹ In his account of the Austrian campaign of 1809, Larrey wrote: "The wounded who were most exposed to the cold, damp air of the chilly, spring nights, after having been subjected to the quite considerable heat of the days, were almost all attacked with tetanus, which prevailed only at the time when the Reaumur thermometer varied almost constantly between the day and the night by the half of its rise and fall; so that we would have it in the day at 19°, 20°, 21°, and 23° above zero (75° to 84° F.), while the mercury would fall to 13°, 12°, 10°, 9°, and 8° during the night (50° to 61° F.). I had noticed the same thing in Egypt."

lodged, may be detected and removed; these being either the missile itself (small shot, bullet, or shell-fragment), which has not passed through and out, or other substances carried in with the ball, such as coins, keys, fragments of watches, etc., and especially punched-out pieces of clothing.¹

Bird-shot, fired from a distance, and small pistol bullets, are very likely to lodge, often being much flattened, generally from striking upon bone. Angular pieces of shell, if projected edgewise, are almost certain to lodge, even when of large size; cloth, when carried along with a bullet, though occasionally adhering as a cap or even complete covering, is generally left somewhere in the track, whether the wound is penetrating or perforating, and under such circumstances, if not removed, remains as a constant source of irritation, with resulting sinus and attendant discharge, due, according to Neudörfer, to the organic nature of the material. The sooner the exploration is made the better; since the search is less painful at first than it becomes subsequently, and since the track of the ball is then more open, and therefore more readily followed. After the inflammatory stage has set in, the wound should be left undisturbed until suppuration is well established, any interference with it at this time being likely to increase the existing irritation. The most serious results, even in some cases the development of tetanus, have been produced by such inopportune exploration.

For the discovery of foreign bodies, the finger is by far the best of all instruments, and it should always be employed when the size and length of the track will permit. In other cases, the probe must be used, either the ordinary probe of the pocket-case, or a much longer one (which, however,

Fig. 266.



Vertebrated probe (Sayre).

may easily be made in two or more segments, and thus readily carried), or a vertebrated, or better, spiral probe, which, by its flexibility, will more readily follow the course of the ball. But of the use of any of these probes, it may still be said, in the words of Paré: "Oftentimes you shall scarce by this means find the bullet," and only by lucky chance a piece of cloth, the presence of which can, as a rule, be recognized only by the finger.

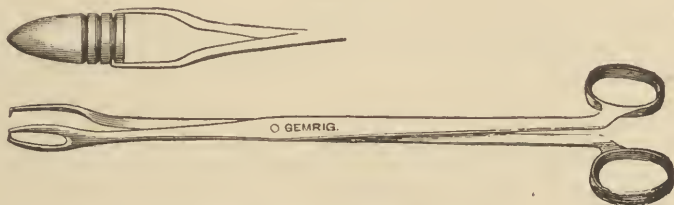
Are all wounds to be explored? In civil practice I believe not, or at least not to any great extent. Very frequently the injury has been inflicted by scattered bird-shot, or by a pistol ball of small calibre. In the former case, if the lead does not lie near enough to the surface to be felt upon palpation, much less damage is likely to result from its presence than from attempts to find it. In the latter, if judicious and not long continued probing fails to reveal the location of the little bullet, it may safely be left, either to become encysted or to be loosened and brought to the surface in the process of suppuration. When the wound has been made by a musket ball, or by a pistol ball of large size, the case is altogether different. Here an exploration should always be made, so that it may be known what damage has been done, and so that the

¹ The sizes and kinds of foreign bodies that may be lodged, sometimes unknown to the patient and unsuspected by the surgeon, almost surpass belief: a round shot of 32 lbs. weight "buried itself under the skin and muscles of the hip" (Hennen); one of 12 lbs. in the thigh (H. W. Davis); one of 8 lbs. in the thigh (Guthrie); one of 6 lbs. under the scapula (Chienn); one of 5 lbs. in the thigh (Larrey)—the four last mentioned having been discovered only upon amputation.

nature and location of the foreign body may be determined. But a penetrating wound of either of the three great cavities, no matter how made, is to be explored only so far as to prove that the bullet has passed through the wall. Though by judicious probing, as we shall see hereafter, it may be possible to ascertain the location of a missile, and thus determine the feasibility of an attempt at removal; yet the most experienced surgeon may easily and unknowingly produce visceral injury in a fruitless effort to trace the course of a shot, and the safest rule for general adoption is that just given. Not so very seldom in pistol wounds, the surgeon and his probe together do more harm than the bullet.

The existence and position of the foreign body having been ascertained, it should be removed, if this can be done without too much risk. For this purpose the finger or forceps, one or both, will usually be employed. Bullet forceps of many patterns have been used from time to time, the best at the present day having rather slender but very firm jaws, with or without slightly projecting teeth that will take a secure hold of the ball. (Fig. 267.) The Coxeter forceps (Fig. 268) has long been a favorite with English surgeons,

Fig. 267.



Bullet forceps (U. S. Army pattern).

but there lies against it the serious objection that it is often very difficult to carry its scoop under and beyond the shot. For the extraction of small pistol

Fig. 268.



Coxeter's bullet extractor.

bullets, or bird-shot, the common dressing forceps answers very well. When the ball is fixed in a bone, or wedged between two bones, an elevator may often be employed to advantage, or a sequestrum forceps, or some one of the many forms of *tirefond* or screw instrument. The bullet can often be removed much more easily through a counter-opening than through the original wound, care being taken to thoroughly fix the foreign body, and to divide all of its coverings by an incision that shall at least equal in length the diameter of the shot. Not infrequently it happens that the extraction of the foreign body is no easy matter; it should never be roughly jerked away, but the track should be enlarged with the knife if necessary.

Much has been written and said about the proper way of grasping the missile, but "the truth is that, on most occasions, one seizes the projectile or the foreign body as he can; the important thing is to seize it firmly, so that it may not escape from the jaws of the forceps during the extraction." As respects pieces of bone, the rule is to remove only those fragments that are entirely detached, leaving the others either to be thrown off at a later period, or

to be incorporated in the reparative callus; the extraction of loose fragments (the primary sequestra of Dupuytren) should be effected as soon as possible, in order to prevent or moderate the irritation that almost always results from their presence—almost always, but not always, for once in a while spicula will be found, long after the receipt of the wound, resting quietly in the midst of perfectly healthy tissue.

TREATMENT OF PRIMARY EFFECTS: HEMORRHAGE.—The immediate effects of the wound, *pain* and *shock*, are to be treated in the ordinary way. What shall be done for the arrestation of *hemorrhage*, is, perhaps, the most important question that can be asked respecting the treatment of gunshot wounds. *Primary bleeding*, as we have already seen, may and often does spontaneously cease. *Secondary hemorrhage*, too, may stop without surgical interference, but comparatively rarely. To control bleeding, resort may be had to compression, to the use of styptics, to the employment of the actual cautery, or to the application of the ligature.

Compression, when it can be properly effected; when there has been a complete division of the vessel, and that not a large one; when there is underneath the artery a firm bony surface, affording counter-pressure; or when the bleeding is venous, oftentimes answers an excellent purpose. When applied, not over the seat of injury, but above, upon the main vessel, or completely around the limb, it is of great temporary value, and may for the time being be the only practicable method of checking the flow of blood; but in military surgery it is well known to be a dangerous measure, being very apt to be too tightly or too long applied, when it produces great swelling of the parts below, if not their actual death. By pressing with the finger in the wound, directly upon the bleeding point, the outflow of blood can be perfectly prevented until time and opportunity have been afforded for the application of a ligature; and it should always be borne in mind that very little direct force is required to stop the circulation through even a large artery.¹

Delayed hemorrhage after amputations, if not in large amount, may often be readily and perfectly arrested by methodical compression with a bandage, thus obviating the necessity of reopening the stump.

Styptics should not, as a rule, be employed for the checking of bleeding, other than that from very small vessels (when pressure or torsion will generally answer better), or from the general surface of the wound—capillary or parenchymatous hemorrhage, which is very often but the precursor of an attack of pyæmia—or when it is from an artery which is deeply seated and difficult to find and take up. Even in the latter case, the use of the persulphate or of the perchloride of iron, which are the styptics ordinarily employed of late, very often fails of accomplishing the desired object, and only serves to waste valuable time, and to put the patient, because of recurrent hemorrhage, in a much worse condition than he was at first. So much abused and improperly employed are these per-salts of iron, that it would certainly be better for the subjects of gunshot wounds if these agents were banished from the surgical pharmacopœia.

¹ As illustrative of the good effect of digital pressure, and of an exceptionally favorable result of compression, may be cited Larrey's case of wound of the external carotid. The ball cut the vessel at its point of separation from the internal carotid, and as it entered the parotid gland. "The fall of the wounded man and the considerable spurt of blood that came through both openings, attracted the attention of the cannoneers. One of them, a very intelligent man, had the presence of mind to promptly thrust his fingers into the openings, and thus stop the bleeding. . . . A methodical compressive bandage, to my great astonishment, arrested the rapid march of death, and saved the officer."

Actual Caution.—The hot iron has often been very advantageously applied to bleeding surfaces, but its use is always attended with risk of recurrence of the hemorrhage upon the detachment of the slough which it produces.

Ligature.—By far the surest and best hæmostatic is the *ligature*, which should be applied, whenever possible, to the wounded vessel just above and below the point of injury. When placed at a distance, on the proximal side, it may control the bleeding; but very often with the establishment of the collateral circulation, the hemorrhage will begin again, and there will then have been added to the original wound one higher up, and with it a new danger from premature separation of the ligature. Dupuytren's opinion that tying the artery in the midst of inflamed and suppurating tissue would probably result in too early cutting through of the thread, and consequent bleeding, has over and over again been proved to have been an erroneous one, and surgeons to-day are almost unanimous in declaring that a wounded and bleeding external artery should be sought for and tied in the wound. It may be found that the blood is issuing from a vessel of but small size, and at times, when the shot track is opened up, the source of the hemorrhage may not be discovered; but the bleeding will nevertheless probably stop not to begin again.

In a musket-ball wound of the popliteal space, secondary hemorrhage came on in such amount as to make it probable that it was from the popliteal artery; yet, when the track of the wound was laid open, I could not find the injured vessel. There was no bleeding afterwards.

Abundant cases are on record, in which ligations of important trunks have been practised—sometimes with resulting death—and in which the hemorrhage has subsequently been ascertained to have arisen from easily found vessels that might and should have been tied.

Shall an artery that has bled, but is not actually bleeding, be ligated? Guthrie said No; but for want of ligation in such a case, when the bleeding has been secondary, many a life has been lost. Though it may not be necessary, it is certainly safer, when the hemorrhage is known to have come from a large vessel, to expose this and tie it; and this should be the rule in all cases other than those of primary bleeding. In these, no operative interference should be adopted until recurrence of the hemorrhage has proved that it is required.

Venous Wounds should be treated on the same principle as those of arteries. Properly applied compression is more likely to produce a favorable result in these than in arterial wounds, and should, as a rule, be the method employed. When, however, a large venous trunk has been wounded, it should be tied. If the opening in the vein involves but a small part of the circumference of the vessel, lateral ligation, as recommended by Travers, may be adopted, but it is very apt to be followed by secondary bleeding. In all cases of wounds of the main venous trunks, there is much danger of resulting death, from gangrene, recurrent hemorrhage, or pyæmia. Langenbeck has advised that in this class of injuries, both the main artery and the vein should be simultaneously ligated, or the artery alone tied, declaring that when double ligation is practised, gangrene of the parts beyond "could only occur if extensive thrombosis of both trunks should prevent the establishment of the collateral circulation;" and believing that "ligation of the wounded vein will without doubt prove unnecessary, and should, as a rule, be avoided, on account of the danger of thrombosis." In such treatment of both the artery and the vein, or simply of the artery, he thinks we have a "sure remedy to control venous hemorrhages that have heretofore been considered absolutely fatal." Whether

or not future experience will establish arterial ligation as the proper mode of practice, is a question. According to Wyeth, of nine cases of simultaneous ligation of both the common carotid artery and internal jugular vein for injuries of various kinds, seven ended in death, and only two terminated in recovery.

In all cases in which ligation is to be practised, much advantage will be derived from the preliminary application of the Esmarch bandage, any necessary dissection being thus rendered very much easier. The elastic cord or band is much to be preferred to the ordinary tourniquet, for the temporary control of bleeding, until it may be practicable to effect a formal ligation. In a paper presented at the late International Congress, at London, Prof. Esmarch laid down, among other propositions, the following, which must command the assent of all surgeons:—

The practice, formerly in use, of ligating arteries above the wound, is uncertain, and ought therefore to be entirely discarded. The application of styptics is equally objectionable, not only because of their uncertain action, but because they foul a wound and interfere with its healing. The use of styptics is very objectionable; all such remedies ought therefore to be banished from the surgeon's field case. In all cases of hemorrhage threatening life, the wounded vessel must, if possible, be exposed at the seat of injury, and ligatured above and below this point, either with catgut or antisepticized silk. The most effectual method to render such an operation easy, rapid, and thorough, is to make a free incision parallel with the axis of the limb. When life is at stake, it matters little whether such an incision is one inch or one foot in length, provided that the hemorrhage is arrested, and that the wound is kept sweet; the large wound heals just as well as the small one. After freely incising the skin, the operator inserts his left index finger deep into the wound, and, with a button-pointed bistoury, opens up just as freely the deeper layers of connective tissue, fasciæ, and muscles, while an assistant now separates the parts with retractors. The blood-clot, which is generally found to fill the wound, and to have infiltrated the surrounding cellular tissue, is now rapidly turned out, either with the fingers, or sponges, or raspatories, partly because it hides everything, and partly to avoid subsequent decomposition. It is only under these circumstances that any operation can be carried out with anything like exactitude. As soon as this is done, the operator feels with his finger for the vascular and nerve trunks, and endeavors with the aid of a clean sponge to learn the exact nature of the injury. When the large veins are empty and collapsed, it is sometimes difficult to distinguish them from strands of connective tissue. On this account it is advisable to provide a little reserve of blood, which may be done in this manner. For the arm, a cord may be fastened around the wrist, below the wound, before the elastic (Esmarch) bandage is applied; then, on loosening this cord and raising the arm, the blood shut up in the hand will, if the vein be injured, flow into the wound, and so make it manifest. As soon as the injured spot of the artery or vein has been laid bare, so that its full extent can be clearly seen, the vessel must be isolated and then securely ligatured, either with catgut or carbonized silk, above and below the injury. If the continuity of the vessel has not already been destroyed by the injury, the vessel must be cut between the two ligatures. The operator should convince himself that no lateral or deep branches are given off to the injured part of the trunk. Should any small branches be found, they ought to be carefully isolated, ligatured, and then separated from the parent trunk. The Esmarch bandage should now be removed, and all bleeding vessels carefully tied, the limb being raised, as after amputation.

Occasionally, the nature of the wound, the position and condition of the bleeding vessel, and the state of the patient, will render it advisable, instead of attempting to control the hemorrhage in any of the above-mentioned ways, to at once perform amputation. Such an operation is much less likely than ligation to be followed by recurrence of the bleeding, the artery very probably being secured at a point where its coats are healthier, and, still more, the *vis a fronte*, which has so much to do with the production of secondary hemorrhage, being altogether removed.

TREATMENT OF SECONDARY EFFECTS.—Aside from the relieving of pain and shock, and the arresting of hemorrhage, the general treatment of gunshot wounds, as ordinarily practised, is very simple, having reference to the moderating of inflammation, and to preventing, as far as may be possible, the development of the secondary local and general infections already referred to. As in other injuries, the maintenance of rest, whether effected by position, by skilful bandaging, or by immobilization, is of great importance. The application of cold, by wet cloths, by irrigation, or by ice-bags, is very generally found to afford comfort and to moderate inflammation, but is not to be employed as a mere matter of routine, but judiciously, with reference to the indications of the particular case; repair has often been much delayed by the too long continuance of cold dressings. Occasionally, though rarely, warm applications prove much more comfortable. In former times, enlargement of the track of the wound, by incision, was the regular practice, and it is still advocated by a few surgeons of eminence, especially among the French, the object sought being to provide a readier outflow for fluids, and to prevent, by division of the fibrous and aponeurotic tissues, any strangulation of the underlying parts. Such immediate dilatation, however, is not at the present day favored by the majority of surgeons, who believe, with Hunter, that the track should not be opened merely because it is a wound, nor unless "there is something necessary to be done which cannot be executed unless the wound is enlarged."

With the object of converting the existing contused and lacerated wound into a simple subcutaneous one, Simon, half a century ago, advocated cutting away the edges of the wound, and suturing the incised skin margins, so that they might unite by the first intention; and thirty years later, Chisolm wrote: "Many ragged wounds may have their edges pared off and then be brought together, with every prospect of speedy union, provided the after-treatment with cold dressing is judiciously followed." Against such a method of treatment, it has been truly said, "both reason and experience protest."

Of extreme value, in the treatment of gunshot injuries, is the observance, as far as may be practicable, of the ordinary hygienic rules; the part and the person are to be kept clean, sufficient fresh air secured, proper food in due amount administered, overcrowding prevented, and the subjects of infectious wound-diseases isolated. A very large percentage of the deaths after gunshot injury are from preventable causes, or causes that would be preventable were it not for the exigencies of military service. Though it must necessarily be of primary importance to cripple and destroy the enemy, and only of secondary importance to save the wounded, yet there is no good reason for crowding men into churches, and barracks, and warehouses; and still less for continuing the occupation of such buildings as hospitals, long after they have become mere hot-beds of infection.

TREATMENT OF COMPLICATIONS.—*Traumatic Gangrene*, when complicating gunshot wounds, and consequent upon extensive blood infiltrations or inflammatory effusions or exudations, follows the same course, and is to be treated in the same manner, as when associated with other severe injuries—special interest attaching to it only when dependent upon excessive violence, destroying at a blow the vitality of the limb, or when due to occlusion of the main artery; the latter is by far the more frequent occurrence. In either of these cases, amputation should be performed at once. As a general rule, it may be declared that when mortification of an extremity sets in after a shot wound of the main artery, or vein, or both, removal of the limb should be effected as soon as possible, and on a level at least with the point at which the vessel is injured. There should be no waiting for the establishment of a line of demar-

cation, for in the great majority of instances this does not form, but there is a rapid and uninterrupted, upward progress of the gangrene, and early death; the exceptional cases of spontaneous arrestation serve only to prove the rule. It is in the lower extremity that the death-in-mass thus occasioned, is usually seen, as a result of a wound of the femoral or popliteal artery. As has already been mentioned, in cases of such injury, a successful result will frequently attend amputation just below the knee, the blood carried through the unharmed profunda artery sufficing to keep alive the parts around and above that joint. In all cases of traumatic gangrene, great attention must be paid to the hygienic surroundings of the patient, and to the proper administration of food, stimulants, and tonics.

Hospital Gangrene.—In the treatment of hospital gangrene, two things are aimed at: the arrestation of the local mortification, and the prevention of the spread of the disease.

The former indication requires that the wound should be carefully cleansed, and then thoroughly cauterized. The strongly adherent sloughs will usually have to be taken away with forceps and scissors (or knife), any existing pockets or sinuses being freely laid open; and the work of removal is to be continued until "we meet evidences of vitality, or by hemorrhage are warned to go no further." (Weeks.) The parts are next to be well scraped—to still further get rid of the diseased tissues—freely washed with warm water, plain or carbolyzed, and afterwards dried by the application of lint, oakum, absorbent cotton, or blotting paper. Then, and not until then, the cauterization is to be accomplished, and the utmost care must be taken that no portion of the wound is left untreated. Of the many cauterizing agents that have been used, the best are the hot iron, nitric acid, the permanganate of potassium, the perchloride and the persulphate of iron, and bromine. Turpentine, sugar, glycerine, and camphor have been largely used, but the results, though satisfactory in the milder cases, are not such as to warrant the adoption of these agents in preference to those previously mentioned. During our late war, bromine was found by the majority of surgeons who saw much of the disease to be the most reliable application, promptly stopping local extension, and promoting rapid healing.¹ In the few cases that came under my own observation, the permanganate of potassium was employed with very satisfactory results.

The acute pain, which is often so prominent a symptom of the disease, necessitates the use of opium or morphia, in full doses, or, as has lately been recommended, chloral, which, however, can act only as a calmative or hypnotic; when it will answer the purpose, it is preferable to opium, as not impairing the appetite nor producing constipation. Hemorrhage, if it occurs, is to be arrested in the ordinary way, by the application of the actual cautery, or one of the salts of iron already mentioned, if the bleeding is from the general surface; by the use of the ligature, if it is from a vessel of some size. The patient is to be well nourished, and stimulated if necessary; the bad effect of depressants was long ago established. An abundant supply of pure air is always to be secured.

To prevent the spread of the disease, those affected must be separated from the rest of the wounded, and there should be absolutely no communication between the gangrenous and non-gangrenous patients, whether by attendants, by dressings, or by currents of air. An infected ward or an infected hospital should be abandoned—permanently if possible, but, at all events, temporarily.

¹ F. H. Hamilton, Jr., showed that the average duration of treatment was less than one-half of that after the application of nitric acid.

If, however, its occupation must be continued, though this seldom need be the case in military practice, we have in antiseptic surgery, as we shall see hereafter, a more or less complete protection for its wounded inmates. Hospital gangrene ought not to appear spontaneously in a hospital, and its development *de novo* is a positive proof of maladministration—the fault being either in the building, its ventilation, or its drainage, or in the responsible officer, by his permitting or compelling over-crowding. The disease may, however, be brought into any hospital, no matter how well managed, and the most prompt isolation may not always prevent infection; but only by isolation can the spread of the affection be prevented.

Pyæmia, Septicæmia, etc.—The treatment of the other so-called “hospital diseases,” septicæmia, pyæmia, and erysipelas, when they occur as complications of gunshot wounds, differs in no respect from that which is appropriate when they are met with in ordinary civil practice. If possible, their subjects should be taken out of hospital, and placed under more favorable hygienic conditions.

Sédillot has declared that he has “seen numerous examples of wounded men attacked with pyæmia, who had recovered after amputation, after having been moved to other more salubrious places;” and amputation or resection is always indicated in severe wounds, especially of the larger bones or joints, when this complication appears.

Tetanus, when it occurs, which is fortunately not very often, cannot, if acute, be controlled in the vast majority of cases by any treatment whatsoever. Notwithstanding the fact that, since the days of Hennen, curare, calabar, chloral, and the bromides have been introduced, and each declared to be curative, the surgeon must still say, with that author, “My observations have tended more to show me what I could *not* trust to, than what I could place the smallest reliance on, when the disease was once fully formed.” Amputation and nerve-stretching have occasionally been followed by recovery, but usually by death. Of the four cases of recovery from the acute form of the disease reported from our army during the war of the Rebellion, two were after amputation. The cases of tetanus among the wounded of the great wars of the last twenty years “have not modified the conclusion of Romberg, that, wherever tetanus puts on the acute form, no curative proceedings will avail, while in the milder and more tardy form, the most various remedies have been followed by cure.” (Otis.)

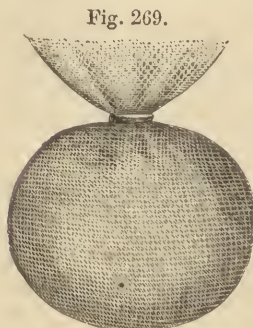
ANTISEPTIC DRESSINGS IN GUNSHOT WOUNDS.

As respects the general treatment of gunshot wounds, the most interesting question of the day is: What is the value, and how wide the applicability, of the antiseptic dressing in this class of injuries? Almost all the deaths after gunshot wounds, which are not fatal because of the vital importance of the parts damaged, are consequent upon protracted suppuration, or upon the inflammatory complications which have been noticed. Eliminate these mortiferous causes, and the prognosis at once becomes comparatively favorable. Is it true, as averred by MacCormac, that “it is not the presence of the ball, nor the fact of the bone being splintered, which occasions inflammation and suppuration, but the entrance of septogenic matter from without, or of pieces of soiled clothing carried in by the ball?” or, as declared by Nussbaum, that “the fate of a wounded man depends almost entirely upon the surgeon who treats the wound during the first hours?” That in the past few years, in

civil practice, severe compound injuries, very analogous to those produced by gunshot violence, have under this plan of treatment been recovered from in extraordinarily large numbers, is a fact that cannot be disputed. That local and general diseases, unquestionably consequent upon wound-infection, have been very greatly lessened in frequency of occurrence, and that, too, in hospitals where previously they had been most prevalent, is undeniable. Are the changes that have lately taken place in the course of wounds due to their less frequent disturbance, their more careful cleansing, their more complete drainage; or are they due to the employment of germ-destroying agents, or to the filtration of septic organisms from the air that is permitted to come in contact with the injured tissues? The question may be readily answered; but will future experience prove the correctness of the answer?

If the "antiseptic treatment" is to be carried out in its strictness, the injured man must not be touched until it is possible to antiseptically explore the wound, remove the foreign bodies, make the necessary counter-openings, put in the required drainage-tubes, and apply the investing coverings and bandage.

All this can never or only very exceptionally be done on the field; and the primary dressing must consist in simply covering the wound with an antiseptic tampon of "salicylic wool contained in salicylic gauze, and inclosed in a square of oiled paper" (Esmarch), or of "chloride of zinc jute inclosed in gauze" (Bardeleben), and holding this tampon in place by a bandage. Possibly, some other agents (such as boracic acid, eucalyptol, or iodoform) may hereafter prove more advantageous and of easier application.



Bardeleben's antiseptic tampon.

"Nothing is more disastrous to the possibility of an aseptic course than the 'regulation search' immediately after the receipt of the injury, and the repeated examination of the wound by the finger or instruments to discover the ball, or to diagnose the extent of the damage to the bone. It is impossible for

either finger or instrument to be clean." (MacCormac.)

No harm will result, it is claimed, from a delay of one or even two days in the examination of the wound, providing that the above mentioned tampon is kept constantly applied, a clean one being substituted for the soiled one as often as may be necessary. Cammerer, in the Servian war, found it possible to render the wound aseptic even as late as two weeks after the receipt of the injury. If fracture of an extremity has occurred, immobilization is to be at once effected as perfectly as may be possible. When the patient has finally reached the "thoroughly well organized hospital" in which he is to be treated—

"Any foreign bodies (bullets, bits of bone, fragments of clothes) which may be found, should be removed. Should any nerve trunks or tendons have been divided, their extremities must be sought for and sewn together, either with fine catgut or carbolized silk. The whole wound must now be thoroughly disinfected, either by irrigation or by rubbing in chloride of zinc or strong carbolic solution, taking care that the fluid gets into every little recess. After counter-openings have been made in suitable places, and drainage-tubes put in, the wound must be closed with antiseptic sutures, and finally the antiseptic compressive dressing applied." (Esmarch.)

The results of this system of treating severe gunshot wounds, as practised by one or two of the few surgeons who have made considerable trial of it in recent wars, we shall notice hereafter, when upon the subject of bone and joint injuries. Early in 1871, A. Guérin, having, during the preceding six months of the siege of Paris, lost all but one of his amputation cases, adopted

the *cotton-dressing*, intended by filtration to exclude all atmospheric germs; and, as the result of such treatment, of thirty-six patients submitted to amputation from April to June, but thirteen died; one-half of the thigh amputations were saved. Originally placing the cotton directly upon the surface of the wound, and keeping its edges apart, Guérin subsequently so modified this dressing that it was placed upon the cutaneous surface of the flaps, previously brought together by several points of the interrupted suture. The advantages claimed for this method of dressing, besides its germ-excluding power, are the gentle and elastic pressure which it exercises, and the uniform and sufficiently elevated temperature which it maintains. It has never been much employed except by a few of the French surgeons, and by them chiefly or only in the treatment of amputation wounds.

GUNSHOT INJURIES OF BONES AND JOINTS.

Aside from penetrating wounds of the cavities and injuries of large vessels, the great majority of dangerous gunshot wounds are those involving bones and joints.

CONTUSION OF BONE.

When it is struck by a ball, a bone may be either contused or broken. As the result of a grazing shot, moving at a high rate of speed, or of the more direct blow of a small or large body whose velocity is not sufficient to produce fracture, the osseous tissue may be bruised; the consequences of such an injury differ from those of contusion of the soft parts only as far as they are necessarily modified by the peculiarities of histological structure. There may be either a simple jarring, attended by no appreciable symptoms other than those of the associated injury of the overlying tissues; or, what more often takes place, there may be limited blood extravasation and consecutive inflammation; or, as has been occasionally noticed, there may be immediate death of the bone at the point struck, and for a variable distance around. The first of these morbid conditions is of little importance, and is quickly recovered from, while the last can only result in the loss of the damaged part, the process of separation beginning very early, and being completed usually in from six to eight weeks; the thickness of the separated piece varies from that of the most superficially exfoliated scale to that of the bone itself, as, for instance, the two tables and interposed diploë of a part of the cranial vault.

As, ordinarily, contusion of the soft parts causes inflammation of them, so contusion of bone gives rise to periostitis, osteitis, or osteomyelitis—the three essential parts of bone (periosteum, bone proper, and medulla) being commonly associated in the morbid process. This inflammation ends in its usual ways: in resolution, in new formation, in gangrene or in suppuration, circumscribed or diffused; the two last mentioned terminations are by far the most important. Not so very seldom, *neerosis* involving a considerable part of a long bone is produced by the jarring and resulting osteitis of a raking shot. I have had occasion to remove from the tibia a sequestrum 8 inches in length, which resulted from the passage of a bullet across the bone just below the tuberosity; and Lidell has reported a very similar case (the bullet passing “across the tibia about four inches below the patella, bruising the bone and slightly grooving the surface”), in which, five months after the receipt of the wound, “a large part of the shaft of the tibia was necrosed and loosened, but not sufficiently detached to justify removal by operation.”

Suppuration may be either periosteal or the result of osteo-myelitis. In

the compact tissue, it may or may not be associated with necrosis, and in the medullary cavity, may involve either isolated portions of the medulla—the pus being in small, distinct pockets—or may be diffused. In diffused medullary suppuration, which is always consequent upon a high degree of inflammation, and which generally occurs in debilitated subjects, or in those placed under most unfavorable hygienic surroundings, the medullary canal is filled with a mixture of unhealthy pus, blood, and broken down marrow. In this putrid osteo-myelitis, especially when affecting spongy bones, moist gangrene (the *mephitic gangrene* of Lidell) may, though rarely, be developed; the bone being “moist, dirty gray, dirty pale green, or dirty greenish-brown in color, and exhaling to a greater or less extent the intolerably offensive odor of rotting bone.”¹ These suppurative inflammations are very likely to give rise to general infection, and a large percentage of their high mortality is due to pyæmia. As Fayrer has said, “it is not the mere local mischief that one dreads, although that may cause the loss of the limb. It is the constitutional disease to which it gives rise . . . that we must consider the great source of danger.”

There may be, in the milder cases, no symptoms other than those referable to the accompanying injury of the soft parts, and even when there has been killing outright, delay in healing or re-opening of the apparently closed wound may at times be the only effect produced by the presence and elimination of the dead bone. In the severer inflammations which yet do not terminate in pus formation, the osteitis may generally be diagnosticated by the character of the pain and the nature of the swelling of the affected part; as it may in the milder, externally located, suppurative cases, after a time, by the added discharge of pus, the detection with the probe of denuded bone, and the associated constitutional symptoms. In the very grave form of osteo-myelitis which is ushered in with a chill and attended with delirium, the acute inflammation, if it does not cause death within a few days, is likely to abate, and recovery may ultimately take place after separation of the necrosed bone. In many of these cases, there comes on “from the tenth to the twenty-fifth day a new fever, with an intense initial chill followed after a day or two by several more; then all the symptoms of purulent infection are developed. As death is the ordinary termination of this complication, an autopsy permits us to recognize the lesions of putrid osteo-myelitis, and often, at the same time, those of a suppurative phlebitis which is equally putrid in most of the cases of this sort.” (Gosselin.)

TREATMENT.—When there are no symptoms apparent, except those of an ordinary contusion or wound of the soft parts, treatment of the latter is all that will be required. When to these are added symptoms indicative of necrosis, nothing should be done until the dead piece is separated, when it should be speedily removed. In the much more common cases of periosteal or osseous inflammation, if the symptoms are at all grave, the surgeon, in addition to the ordinary constitutional and local antiphlogistic treatment, should make a free incision through the periosteum, and, if the disease is not superficial, a longitudinal section of the bone with a Hey’s saw; or should open the medullary cavity with the trephine.

If a considerable part of the shaft of a long bone is found to be involved, or if the severity of the constitutional symptoms shows that the disease is of the diffused, suppurative, or gangrenous form, amputation in contiguity, at the articulation next above, should be resorted to at once; and even when pyæmic symptoms have manifested themselves, the patient may occasionally,

¹ A like condition is at times met with in long bones “as the result of violence which suddenly deprives the part of its vitality.”

though rarely, it is true, be saved by such an operation. Amputation in continuity, except in slowly progressing cases, is of no benefit, the disease quickly re-appearing above the line of section. When the symptoms are less acute, and the patient has survived the dangers of the earlier weeks or months after the receipt of the injury, secondary disarticulation may be practised with strong probability of a successful result. A chronic osteomyelitis—not likely to follow contusion, but not infrequently met with after gunshot fracture—may spontaneously terminate in the death of the affected part, removal of which will be soon followed by complete recovery from the injury; or it may slowly but very surely go on to the involvement of the whole bone, necessitating amputation at the joint above. The progress of this form of the disease is at times exceedingly slow.¹

If possible, infectious bone-inflammations should be prevented rather than treated, and it is to protection against the occurrence of these septic processes, and thereby against blood-poisoning, that methods of dressing must in the future be directed. "Listerism" has already been tried on a limited scale in these cases, and in civil practice it can, under favorable circumstances, be thoroughly carried out; but in military surgery, it must ordinarily, or at least often, be almost if not altogether impracticable. As far as can possibly be done, the parts should be kept quiet and clean, free drainage secured, over-crowding prevented, and abundant fresh air supplied.

FRACTURE FROM GUNSHOT INJURY.

Of greatly more frequent occurrence than *Gunshot Contusions* of bone are *Gunshot Fractures*.² These fractures may be *simple* (in only a few cases, and then almost always not directly produced by the impact of the projectile), or *compound*; they may also be classified as *fissured*, as *comminuted*—sometimes extensively, with a variable amount of scattering of the fragments—as *penetrating*, as *perforating*, or as "*resecting*"—the missile carrying away the entire thickness of the bone for a greater or less distance, with little or no associated splintering. The extent of damage done depends in great measure upon the size and velocity of the shot, and has been therefore found to be much greater in recent wars than formerly. In a comparatively few cases, round balls or pistol bullets or, yet more rarely, the modern, elongated rifle ball, has bored through a bone (if a long one, usually near an articulating extremity) without producing any splintering,³ the osseous tissue being in part condensed, in part carried on into the neighboring soft structures. Penetration with lodgment may occur, even (though but seldom) in a diaphysis, without other bone lesion. But in the great majority of cases, when a ball strikes a bone, it either splits it or shatters it according to the manner in which the force is applied. The conical bullet exerts a wedge-like action: striking an epiphysis, it may simply fissure it, the cracks extending "perpendicularly upwards and downwards without perforating the articular cartilages. Such fissures are more or less frequent, especially when great force is applied, *i. e.*, when the channel made by the shot is long."

¹ In a case under my care, in which, in October, 1880, I successfully amputated at the hip-joint, the operation was rendered necessary by a gunshot fracture of the femur in its middle third, which had been received 33 years before in the battle of Molino del Rey, Mexico, in September, 1847.

² Of more than one hundred thousand (107,898) wounds summed up by S. W. Gross, nearly ten per cent. (9.64) were fractures of long bones, including among these the clavicle and scapula.

³ Becher reports having seen a number of such cases, the wounds having been made by the chassepot bullet of 380 grs. weight.

The diaphyseal fractures, according to Bornhaupt, "sometimes resemble a stick bent in its longitudinal axis; or a ring compressed from two opposite sides. In the first case, there may be simple transverse fracture¹ (mostly through spent bullets); in the second, two, three, or four longitudinal fissures. If the diaphysis be injured more towards the middle part, then the two mechanisms combine in the production of a peculiar form of fracture, viz., the '*spiral longitudinal fracture*.' The bone divides into four fragments; in addition to an upper and lower fragment, two triangular splinters are to be found opposite the part which has been struck, forming the posterior longitudinal fissure. When the bullet has not hit directly the posterior wall of the bone, the longitudinal fissure originates through direct force, and not through the hydraulic pressure of the marrow." It is to this "pressure developed by projectiles in the liquids which they traverse," that Kocher has attributed, "in great measure, the lateral splintering produced by the ball." Otis has called attention to the fact that when the femur has been struck by a heavy conoidal ball, in addition to the damage at the place of impact, there is, at times, an added transverse fracture two or three inches above or below, according as the shot has struck below or above the middle of the shaft.

However extensive the splintering, if consequent upon a bullet wound, the fissures generally, at least in children and young adults, do not extend beyond the epiphyseal line; and in some cases in which they run through the articulating extremity, "the synovial membrane remains intact, and the joint is not opened."

It would appear from the observations and experiments of Kircher and Longmore, that though there is, as the result of the blow of the conoidal bullet, more extensive splintering than when the injury is inflicted by a round ball, there is not so much separation of the fragments, which are to a considerable extent held in place by untorn periosteum; and, further, that the hardened bullet does not as extensively comminute nor as widely scatter the pieces of the broken bone as does the soft lead one. In accepting this latter conclusion of Mr. Longmore, due allowance must be made for the difference in diameter of the bullets used, that of the Enfield pure-lead ball being .55 in., and that of the Martini-Henry lead-and-tin ball .45 in. The probability of recovery with preservation of a useful limb, if the wound is located in one of the extremities, is, of course, much greater, other things being

¹ In the Army Medical Museum at Washington there is a specimen of "the left clavicle transversely fractured, without comminution, directly in the middle. (Fig. 270.) The missile

Fig. 270.



Transverse gunshot fracture of right clavicle by conical ball. (A. M. M. Spec. 1210.)

was a conoidal ball which entered near the third dorsal vertebra, fracturing the corresponding rib at its angle, and was found after death encysted immediately beneath the fractured point of the clavicle." MacCormac reports a case in which "the ball entered on the inner side of the right thigh, close to the perineum, and after traversing the femur just beneath the lesser trochanter, emerged on the outer side of the thigh. There were, when first examined, two inches of shortening and great deformity. The fracture must have been almost a transverse one, for the bone, after considerable extending force had been applied, went into its place with a jerk, and there remained. The patient recovered without a bad symptom, and the most accurate measurements failed, six weeks afterwards, to detect any appreciable amount of shortening."

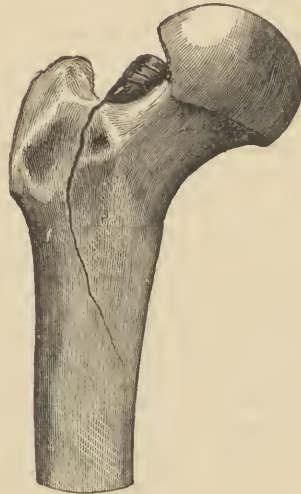
equal, when the fragments are held in close apposition than when they are separated; and Kircher, who declares that wounds from conical bullets heal more readily than those from round ones, believes that there is at times, because of the fixation of the pieces by their unruptured periosteal covering, union of the fracture without suppuration.

Fig. 271.



Fissured gunshot fracture of right humerus removed by amputation. (A. M. M. Spec. 486.)

Fig. 272.



Fissured gunshot fracture of right femur by conical ball. (A. M. M. Sect. 1, Spec. 3931.)

The danger to life in gunshot wounds of bone lies in the liability to the occurrence of fat-embolism, of violent inflammation, of blood-poisoning, or of exhaustion or amyloid disease from profuse and protracted discharge of pus.

TREATMENT OF GUNSHOT FRACTURES.

The treatment of gunshot fractures must have reference to the condition of the injured part, and to the various constitutional symptoms which may be developed. *Primary* splinters, that is, those entirely detached, should be removed at once. Upon this all are agreed, unless the case is to be treated antiseptically, when, as we have already seen, the cleansing of the wound and removal of foreign bodies (and such are these bone fragments) are to be postponed until circumstances will permit of a systematic dressing, or, indeed, may be omitted altogether if the pieces are not large—some (as, for instance, Schmidt, of St. Petersburg) going so far as to declare that extraction of splinters is only necessary when sepsis has occurred. Whether or not *secondary* sequestra (those still somewhat attached) shall be taken away, must depend upon the extent and degree of their adherence. If simply held by narrow bands of periosteum, the sooner they are removed the better, for their vitality cannot long be maintained. If more firmly united to the unbroken part of the bone, even though standing off at a considerable angle, they will often, if left undisturbed, be included in the callus, and contribute effectually to its development and strength; the disadvantage of their retention is the danger of necrosis, and the consequent persistence of sinuses until the dead fragments

are removed. Great annoyance and even fatal visceral disease are sometimes caused in this way. Necrosis may thus occur years after the apparent firm consolidation of the fracture, when from any cause whatever the general health becomes seriously impaired.

In cases of fissuring without separation, or where the periosteal investment of the fragments is not much disturbed, these should be left untouched. In gunshot as in all other fractures, it is of the utmost importance to hold the fragments in apposition, as far as can be done; and no matter what bone it may be that is damaged, rest as complete as possible of the injured part should be secured—by dressings, if they can be applied—otherwise, by position. In the extremities, where, according to Sédillot, “ever since firearms have been used on the field of battle, and in sieges, the same question has always presented itself to surgeons: viz., in what cases should fractured limbs be saved, or sacrificed in part (resection), or in whole (amputation)?”—if an attempt at preservation is made—the injured part together with the joints next above and below should be at once immobilized. The less the wound is disturbed, and the more completely movement of the fragments is prevented, the better are the chances of recovery.

To secure the necessary quietude of the damaged tissues, the application of a plaster-of-Paris dressing¹ is of great value, and it matters little what particular form of the dressing is employed—the continuous roller, or the Bavarian, or longitudinal strips—provided that the immobilization is sufficiently made, and, what is of much importance, that the wound itself is not covered in, and the limb not constricted at that level. If the patient is not to be moved, and can be constantly kept under proper observation, the latter point need not be so much regarded, since the investing bandage can be at once sufficiently cut open if the swelling necessitates it. It has been objected to this method of dressing that the opening opposite the wound weakens just where there should be the greatest strength; that the splint will soon break in transportation; and that it quickly becomes soiled by the discharges, which both render it offensive and rapidly soften it so that it no longer possesses the requisite firmness. These are certainly not insuperable objections; the fenestrum may be bridged over with a piece of tin, iron, wire-gauze, or even wood; a properly made bandage will stand the jolting of any ordinary transportation; and, by the use of oiled silk or thin rubber cloth, the fluids from the wound can be kept off the plaster. Great advantages are claimed for wire-gauze splints, that can by pressure of the hand be moulded to the shape of the broken limb, and yet are firm enough to keep the parts quiet, and to permit the patient to be removed, if necessary, by ambulance or rail.

Beside external support, there must be protection from the danger consequent upon the retention of extravasated blood and effused serum; in other words, free drainage must be secured by counter-openings, by position, or by tubes, one or all. A gunshot fracture does not differ from an ordinary compound fracture, except in the frequent smallness of the wound in comparison with the extent of the injury, and the same general principles must govern the treatment of both sets of cases. The essential requisites for successful conservatism, in either case, are the securing of rest, cleanliness, and thorough drainage. Future experience must determine the value of the antiseptic dressing. As we have already seen, its formal application on the field is, at least in its entirety, seldom practicable; yet the comparatively few trials that have been made of it in military surgery, show very clearly that its primary application, before inflammation has set in, gives very much better results than those

¹ The use of plaster was recommended as long ago as 1814 by Hendriksz, of Holland, and Pirogoff employed the plaster bandage in 1854 during the Crimean war.

obtainable when it is secondarily resorted to. Reyher, for instance, out of 22 cases treated in the former way, lost but 4, or 18.1 per cent. (from septic inflammation 1, from pyæmia 1, from fat embolism 1, from extravasation 1); three of these (out of six in all) being wounds of the thigh, and one (out of three) a wound of the forearm, while of 65 cases in which the antiseptic method was only applied secondarily, 23 (35.2 per cent.) terminated fatally: 5 of the arm, out of 12 cases; 13 of the thigh, out of 25; and 5 of the leg, out of 22—13 of these 23 deaths having been from septic phlegmon and pyæmia.

EXSECTION IN GUNSHOT FRACTURE.

Putting aside, for the present, excisions of the articular extremities for fractures involving the neighboring joints, and taking no account of removals, more or less extensive, of detached fragments, with or without associated cutting away and rounding off of the sharp ends of the upper or lower unbroken parts of the diaphysis, there remain for consideration *Resections in Continuity*, and entire *Extirpations* of fractured and necrosed bones. It may be said in general, of the former operations, when primary, that the mortality which attends them is higher than that of the simpler informal removal of fragments, and that the ultimate results, as far as the functional value of the damaged parts is concerned, are no better, if as good. It should never be forgotten that, as Sédillot has said, these resections, "sanctioned neither by theory nor by experience, . . . cannot be done without great disturbance and violence, and an unavoidable increase in the extent of the wounded surfaces." Nor can early, complete extirpation be regarded more favorably; only exceptionally can it be justified, and, even then, as satisfactory a result would probably follow extraction of the entirely detached pieces of the broken bone, or, on the other hand, it might be better to amputate. Secondary operations, whether partial or complete, for necrosis, or more rarely for caries, may be both proper and necessary; and they should be determined upon, and executed, upon the same general principles as when the death of the bone has resulted from causes other than gunshot injury.

AMPUTATION FOR GUNSHOT INJURY.

Excellent as are the results that frequently attend attempts to save fractured limbs, in an unfortunately large number of cases removal of the injured member will prove to be the truest conservatism, the lesser being sacrificed for the good of the greater. Joint injuries excluded, when should amputation be resorted to?

(1) When there has been *great destruction of soft and hard parts*, as in a crush by large shot, or when the limb has been almost completely or altogether carried away. Under such circumstances, the operation would naturally be performed at once, and, if possible, at a high enough point to get above the region of contused and blood-infiltrated tissues.

(2) When the fracture is associated with *laceration of the main vessels or nerves* of the part, though, as will hereafter be seen, in certain regions such complicated fractures may be conservatively treated with good prospect of success.

(3) When *acute, infective osteomyelitis* has been developed. In the *chronic* form of this disease, when the entire length of the bone has become affected,

Fig. 273.



Necrosed lower part of humerus, with parts of radius and ulna removed by excision. (Cutter.)

it may or may not be necessary to amputate, according to the general condition of the patient and the particular bone that is diseased. If the general state is good, and the affected bone not absolutely required for support, excision may very properly be substituted, unless it be apparent that the result can only be an useless limb. Even in such a case as that reported by Cutter, in which, after a primary excision of the head of the humerus and a small portion of the shaft, the remainder of the humerus and the elbow-joint were removed by a secondary operation—notwithstanding that it was declared two years later that the limb hung pendulous and useless—still, if the man was able after steadying the forearm to satisfactorily use his fingers, he was certainly better off than if there had been a disarticulation at the shoulder. In many of the cases of chronic osteomyelitis of the bone or bones of a stump, reamputation in contiguity is unnecessary, it being sufficient to fully expose the end of the bone, and forcibly pull out the sequestrum.

(4) When there is severe *secondary hemorrhage* from an eroded vessel, or from a ruptured traumatic aneurism.

(5) When *traumatic gangrene* has supervened. The development of *tetanus* may also be deemed an indication for amputation. In cases of gunshot injury other than those involving the bones and joints, amputation may be rendered necessary by the large extent of the

laceration, by the injury of the great vessels or nerves, or by the complication of gangrene or tetanus.

When evidently necessary by reason of the locality and extent of the injury, amputation should be resorted to as soon as shock has been sufficiently recovered from, before the development of inflammation, which may show itself some hours, or not for several days, after the receipt of the wound—ordinarily in not less than eight nor more than twenty-four hours. Even at the hip, Otis's observations "do not sanction the conclusion that ablation of the thigh is an exception to the general rule requiring amputations that are indispensable to be done immediately." These *primary* operations are much less fatal than those which are performed during the period of active inflammation¹—the so-called *intermediary* operations—when indeed no avoidable surgical interference of any kind should be permitted. With the subsidence of acute inflammatory symptoms, and the thorough establishment of suppuration—in from ten to thirty days, according to circumstances—begins the period of *secondary* amputations, the mortality of which is between that of the primary and intermediary. As in removal of limbs on account of the ordinary injuries of civil life, no more should be taken away than is absolutely necessary; but as a gunshot injury generally damages parts at a considerable distance above the point struck, the place of operation must be selected accordingly. An amputation in contiguity should always be preferred to one higher up, if the condition of the soft parts will permit; for instance, through

¹ In nearly ten thousand (9891) primary amputations in military surgery tabulated by Ashhurst, the mortality rate was 37.6 per cent., while that of 3775 late operations was 43.3 per cent., and a large proportion of these were undoubtedly secondary. (See Vol. I., page 635.)

the knee-joint (or at the knee), rather than at the lower third of the thigh.¹ As a rule, having, however, numerous exceptions, such an amputation is also to be preferred to one in continuity just below, as, for instance, that through the tuberosities of the tibia, which was so much favored by Larrey. The head of the humerus should be saved, however, when possible, since the resulting stump is more shapely than that of amputation at the shoulder, and less likely to be injured in after life (not "useless and inconvenient," as declared by Larrey); again, if an inch or more of the bones of the forearm can be left, the resulting hook, in cases in which the motions of the elbow are preserved, is of great service; and a successful Pirogoff amputation gives a longer, firmer, and better stump than a Syme.

The operative procedure to be adopted in any given case, must depend upon the locality and the condition of the damaged part, and the subsequent mode of dressing should be determined upon the same principles as those governing amputations in general. If the antiseptic system is not adopted, care must be taken to at least secure thorough drainage. Notwithstanding the excellent results that may at times follow the "open treatment," it is, as a rule, desirable to secure union by first intention, as far as it may be possible to do so; and for this purpose bleeding from the cut surfaces must be arrested (preferably by the use of catgut ligatures and hot water); drainage-tubes should be inserted; and the parts should be closely apposed, and held together by one or two deep, and a sufficient number of superficial stitches, aided, if thought best, by the elastic compression of sponge or cotton, held in place by a methodically applied bandage. Due attention must always be paid to what has been styled the "surgery of salubrity."

GUNSHOT INJURIES OF JOINTS.

Joint wounds, which are both frequent and dangerous,² are of two classes: penetrating and non-penetrating—the latter class including wounds and contusions of the overlying soft parts, extending down to the capsule or secondarily causing synovial inflammation, and fractures of the extremities of bones running to but not into the adjoining articulations. Unless the joint has been widely opened, or there is escape of synovia, an early diagnosis of penetration cannot be made, even though the ball has passed in and out, and the line of direction seems to run through the articulation. In a few cases, the ligaments or other periarticular structures cause deflection of the missile, and, on the other hand, because of the length and nature of the bullet track, there may be no outflow of the joint secretion. When the diagnosis is uncertain, the wound is to be explored, if at all, only with the finger; the probe should never be used, for it might very easily pass through an unopened synovial membrane, and thus convert a non-penetrating into a penetrating injury. The chief danger, as in joint wounds otherwise caused, is that of the production of suppurative synovitis, with its resulting local

¹ Few American surgeons will agree with Legouest that the knee amputation is "a bad operation, more dangerous than amputation of the thigh in its continuity, and one that ought to be discarded from practice." Though the correctness of his statement that its mortality (88.7 per cent.) is 13 per cent. higher than that of amputation of the thigh, is sustained by the 88.2 per cent. death-rate of the French operations in the Crimea, and rendered probable even by the 78 per cent. mortality of the 41 cases in the Mexican, Italian, Austrian, and Franco-German wars, tabulated by Salzmänn, it is thoroughly disproved by the fact that in our late war, when at least 211 such operations were performed, the death-rate of 202 ascertained cases was more than 14 per cent. less than that of thigh amputations, 50.2 per cent. against 64.43 per cent.

² Of 12,864 wounds tabulated by Longmore, 403 (3.13 per cent.) were of joints, and of these 130 (32.25 per cent.) proved fatal.

destruction, exhaustion, amyloid disease, or purulent infection; and gunshot wounds of the articulations are more fatal than others, simply because they do more damage to the joint structures and cause a greater amount of hemorrhage into the articular cavity. When the joint has not been opened, the synovitis may be simple, and the prognosis consequently very much more favorable, but oftentimes intra-articular suppuration sooner or later occurs; the overlying structures at times become gangrenous, occasionally, without doubt, not so much because of the original injury, as of the injudicious use of cold applications, combined it may be with compressing bandages.

The extent of destruction of the soft parts may be so great as of itself to necessitate amputation; and in many cases, otherwise successfully treated, decided impairment of the joint or even fixation of it may result from peri-articular cicatricial contraction. In penetrating bullet-wounds, it has undoubtedly happened once in a while that the missile has passed through without injuring the bones, but in the vast majority of these cases, osseous lesion is produced; rarely perforation, or even lodgment, without fissuring or smashing; almost always splintering, often in high degree. The early symptoms, even in these latter cases, are frequently very mild; there may be little or no pain, and no constitutional disturbance. The untorn periosteum may hold together the splintered fragments so firmly that it is difficult or impossible to elicit crepitus, and that it may be possible to use the injured limb, as in a case reported by Legonest, in which though there was a fracture of the cotyloid cavity, the man walked about for ten days after he was shot.

Usually, fever sets in on the second or third day. According to the joint affected, and the extent of its damage, an attempt may be made to save the limb, by cleansing the wound, removing foreign bodies (including all detached pieces of bone), securing drainage, immobilizing the part, and controlling inflammation, particularly by the application of cold; or the injured part may be taken away, either by complete or partial excision of the joint, or by amputation. Until quite recently, the non-operative treatment of wounds of the larger joints was attended with a greater mortality than either excision or amputation; and by the majority of surgeons, operation has been advised in all cases of such injury, excepting those which are very slight, or when the patient's surroundings are unusually favorable. Other things being equal, the chances of saving part and life are much better in joint wounds of the upper, than in those of the lower extremity. In the last few years, a number of severe injuries of the major articulations have been treated antiseptically, with results very much better than those previously obtained in military surgery—the great object being to prevent suppuration, with the setting in of which the chances of recovery decrease very rapidly. (Reyher.) Whether this or the ordinary treatment be adopted, immobilization is of the utmost importance, and equally so, in the ordinary mode of treatment, is the removal of foreign bodies. With the antiseptic dressing this is a matter of very much less importance, as is shown by two of Bergmann's cases in which healing took place, although, as was proved some time afterwards by post-mortem examination—the patients having meanwhile died of intercurrent disease—in one, several small pieces of cloth were shut up in the joint, and in the other, a fragment of bone had grown into the insertion of the crucial ligaments.

Whether, in cases that must be operated upon, exsection or amputation shall be preferred, will depend upon the extent of the laceration of the soft parts and of the destruction of bone, upon the particular joint injured, upon the general condition of the patient, upon whether or not he is to be treated at the place of operation, and lastly, upon his hygienic surroundings. If no use be made

of antiseptics, an amputation wound may be expected to heal sooner and with less suppuration than that of an excision.

The difference in the fatality of the two operations is not very great; the advantage on the side of exsection is, that, if successful, there remains an useful limb. Unfortunately, in no small proportion of the cases of joint removal, though life is saved, the part is of little, sometimes of no value. In about every fortieth case, Gurlt found that the limb was not only useless, but a burden; in one-ninth (75, or 11.5 per cent.) of the 652 cases the "end-results" of which he ascertained, the functional value of the part was *nil*; in one-half (322, or 49.38 per cent.), the limb could be satisfactorily and properly used only with the aid of some prosthetic apparatus; in less than one-third (202, or 30.98 per cent.) was the part quite useful; and in only one in seventeen (38, or 5.83 per cent.) was the functional integrity of the limb completely regained. Occasionally, when the conditions have been exceptionally favorable, and when it has been possible to make the operation sub-periosteal and subcapsular, complete osseous regeneration has taken place, so that even in size and shape the joint has been restored. Practically, a *primary* sub-periosteal resection cannot be effected, and it is an useless waste of time to attempt it. Subsequent amputation has been found necessary in about one case in every twenty (152 out of 3161), with a resulting mortality of 48 per cent. (73 out of 152). Of late-occurring deaths of individuals operated upon more or less successfully, a very considerable number have been from pulmonary tuberculosis; but this form of disease is generally, it is probable, in no way consequent upon either the wound or its treatment.

As respects the time of operation, exsections, like amputations, are divided into the *primary*, the *intermediary*, and the *secondary*; of which the intermediary are most dangerous to life, and the primary least so.¹ Of the six larger joints, the shoulder and elbow are those much the most frequently exsected, the percentage being, according to Gurlt, for the shoulder 45.29, elbow 39.21, wrist 3.62, hip 3.79, knee 3.98, ankle 4.39; the shoulder and elbow together are thus operated upon eighty-five times in every hundred; or, in other words, nearly one-half of the exsections for gunshot injury are of the head of the humerus, and two-fifths are of the elbow.

Although perhaps more properly coming up for consideration under the general head of "injuries of the extremities," it is for many reasons preferable to notice in this connection the wounds of the several major articulations.

GUNSHOT INJURIES OF THE SHOULDER.

The frequent injuries of the shoulder-joint are almost always penetrating wounds, with fractures of one or both of the bones entering into its formation. There may, however, occur also a fracture without accompanying skin laceration, as from a large shot or shell fragment; perforation of the soft parts, with contusion of the joint-structures; penetration without osseous lesion—seventy-two cases of the two last-mentioned injuries were reported during our late war; or, rarely, splintering of the humerus from an injury of its

¹ According to Gurlt's tables, of 1056 primary exsections, 317 were fatal (30 per cent.); of 286 intermediary, 131 (45.80 per cent.); and of 1622 secondary (not including "late" cases and those the time of performance of which was unknown), 610 (37.60 per cent.). That primary operations give the best results, is further shown by the fact that while of 141 German primary operations, 50 (35.46 per cent.) were fatal, and of 1126 secondary, 416 (36.94 per cent.); of 915 primaries during our late war, 267 (29.18 per cent.) were fatal, and of the 496 secondaries, 194 (39.11 per cent.).

diaphysis, the fissures running up to or into the epiphysis, without primarily opening the articulation. (Ordinarily, as has long been known, an epiphyseal line limits the fissuring, whether from a wound above or below.)

In the non-penetrating wounds, the joint may be "confused and wrenched, and filled with extravasated blood; more severely injured than from a simple penetration of the capsular ligament (Neudörfer)," since suppurative synovitis is likely to be developed. As regards the side of the body, the left shoulder-joint is more often wounded than the right, "doubtless due," as pointed out by Otis, "to the exposed position of the left shoulder in firing."¹ Associated with the joint injury, there is often fracture of the scapula or clavicle; damage to the important structures in the axilla, or to the chest walls; and, very occasionally, wound of the chest cavity—a lesion of great danger, which patients rarely survive. At times, the ball penetrates without perforating the head of the humerus (Fig. 274), such cases of lodgment being decidedly graver than those in which the shot has passed through.

Fig. 274.



Musket ball impacted in head of left humerus. (A. M. M., Spec. 2696.)

PROGNOSIS.—The *prognosis* of a shoulder wound, like that of any other, will depend upon the nature of the injury; the size, weight, and velocity of the missile; the presence or absence of complications; the health of the patient when wounded; his subsequent hygienic surroundings; and the treatment adopted; but, speaking generally, it may be said that one-third of the cases will die from blood-poisoning, from hemorrhage, or from the effects of protracted suppuration.

TREATMENT.—Leaving out of consideration cases of such extensive destruction of the overlying soft parts, or crushing of the bones (produced ordinarily by cannon shot), as compels immediate amputation, and those of non-penetrating injuries in which evidently no operative interference is required, the *treatment* of shoulder wounds consists in either amputation, excision, or expectancy.

AMPUTATION.—*Primary* amputation is indicated only when, in addition to the joint lesion, there is either extensive shattering of the humerus, through and beyond its upper third, or laceration of the axillary vessels and nerves; and even in these cases, the experience of surgeons during the wars of the last twenty years has shown that the other plans of treatment may very often be advantageously substituted. Though early removal of the limb may be expected to be recovered from in three out of four, if not in four out of five of the cases operated upon, yet there is incurred during the period of treatment a very decided risk of serious secondary hemorrhage; and the patient, at the best, must go through life with what is, functionally, the severest of mutilations, the loss of a whole upper extremity. An *intermediary* disarticulation should never be practised, unless rendered absolutely necessary by the occurrence of gangrene, of acute osteo-myelitis, or of otherwise uncontrollable secondary hemorrhage; the mortality of such operations is nearly or quite twice as great as that of primary, and almost double that of secondary, shoulder amputation. *Secondary* removal of the limb may be required on account

¹ Harlan writes: "The rule seems proved by the exception, that in cavalry the reverse is the case, as far as I have seen. The right being the sword arm, is, of course, advanced in a charge, as well as in the use of the pistol."

of extensive bone-disease, whether or not there has been previous excision, but rarely for any other cause in cases of wound of the joint or upper third of the shaft.¹ The particular way in which the operation shall be performed, whether by the flap or the ovoid method, will depend upon the character of the injury and the preferences of the operator. For such cases as are commonly met with in civil life, other than those in which a charge of small shot, fired at close range, has torn through the axilla as well as the joint, or the bone just below it, amputation is not to be thought of.

EXCISION.—Very much to be preferred to removal of the limb, is removal of the damaged part. Though the mortality of shoulder-joint excision is somewhat higher (5 to 10 per cent.) than that of amputation, yet the preservation of the arm, especially of the right arm, even though an apparatus must be worn in order to permit its being of much use, is of great importance to the patient, and well worth the additional risk incurred. In an uncomplicated fracture, in which the humerus is not splintered below the line of junction of its middle and upper thirds, or for not more than four inches, excision, if recovered from, may be expected to result in the securing of an useful arm. Even more than this amount of the bone may at times be taken away and the patient do excellently well,² though Gurlt states that of fifteen cases in which more than four inches was removed, twelve had arms the functional value of which was far from good. The partial regeneration of bone which sometimes takes place improves correspondingly the usefulness of the arm.

In a case reported by Chipault, seven months after a secondary excision of five and a half inches, there had been a regeneration of two inches of the shaft, of diameter almost equal to that of the original bone; and the patient was ultimately able to carry the arm four inches away from the body, and to place the hand on the top of the head, the arm shortening, and muscular thickening below the shoulder occurring.

Associated injury of the scapula or clavicle, or both, does not render excision improper: if there is simple fissuring of these bones, operative interference, as far as they are concerned, is not required; but if there is comminution, the broken parts should be taken away. Of forty-two removals, during our war, of the head, or head and shaft, of the humerus, with portions of either scapula or clavicle, or both, thirty-one recovered, only ten per cent. of the primary cases resulting fatally. From the Servian War, five such cases are reported with one death (20 per cent.), all operated upon after the close of the early period.

In nearly one-half of the cases that recover, a very useful limb remains,³

¹ The percentages of mortality of shoulder-joint amputations during our late war were: *primary*, 24.1 (485 cases, 117 deaths); *intermediary*, 45.8 (157 cases, 72 deaths); *secondary*, 28.7 (66 cases, 19 deaths); and of *unspecified date*, 25.5 (110 cases, 28 deaths). In the French army in the Crimean war, the average mortality was 65.21 per cent., and Legouest has placed it in general at 59.5 per cent. It should be always borne in mind that disarticulation is adopted in very many cases for causes other than those connected with the joint itself, and that the mortality must be proportionally affected.

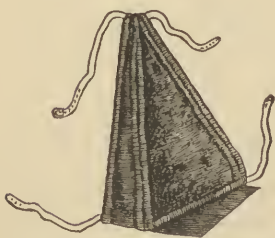
² In a case reported in the "Medical and Surgical History of the War of the Rebellion," the head and *six inches* were removed, and twelve years afterwards, the patient could, without difficulty, place his hand on the top of his head; and could, without pain, lift a weight of two hundred pounds, or more, with the injured limb. The movements of the forearm and hand were not in the least impaired, and there was great freedom of all the movements of the arm, except abduction. The muscular development of the arm equalled that of its fellow. No apparatus was requisite, and altogether the result was most satisfactory and successful.

³ Gurlt (whose great work on "Joint Resections" has been, and will hereafter be, freely drawn upon) states that of 213 shoulder excisions, 94 (44.13 per cent.) afforded useful limbs, while 119 (55.86 per cent.) gave arms the functional value of which was not satisfactory, and which could be well used, if at all, only with some applied apparatus. Under the head of useful limbs, are classed, besides the rarely met with cases in which there is ability to execute all the normal movements of the shoulder—even to vertical elevation of the arm—those in

becoming more so in progress of time; and in the great majority of the remainder, by the aid of proper apparatus, the patient is able to write, feed himself, carry burdens, etc. An immovable shoulder joint seldom results—in less than ten per cent. (9.85) of the cases. In more than one-third of the preserved arms, there is no material shortening, and in the rest, such shortening (which is functionally better than the lengthening that is occasionally met with) tends to become progressively of less importance, the upper end of the humerus being gradually drawn up towards the glenoid cavity and the range of movement increased. The atrophy, which is so commonly seen soon after the wounds have healed, is largely from disuse, and diminishes as the arm is employed.

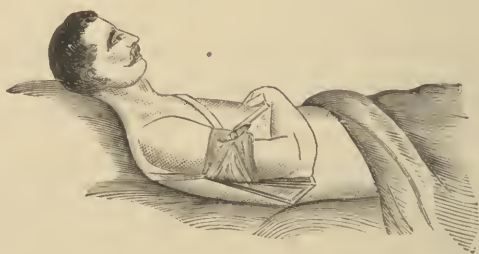
The operation is, as a rule, most readily accomplished by means of the straight incision, no special attention being paid to the location of the bullet wound, the presence of one on the posterior surface of the limb being really of advantage, as facilitating drainage. The ultimate result does not seem to be materially affected by the operative procedure adopted, but does in large measure depend upon the time at which it is resorted to; a *primary* excision, according to Otis's tables, has a percentage mortality of 24.1; an *intermediary* excision one of 45.8, and a *secondary* excision one of 28.7. Gurlt, in his table, which includes nearly 600 (568) additional cases from the German wars, and in which the number of American late excisions is increased by 160 cases carried forward from the intermediaries, gives the percentage of mortality as 31.83 for the primary, 53.12 for the intermediary, and 39.25 for the secondary operations. Either set of figures proves that, at the shoulder-joint, primary excisions are decidedly the best, and intermediary very much the worst, as far as the preservation of life is concerned, though, as respects "end-results," the later operations give decidedly the larger percentage of useful limbs (45 as against 35). When circumstances permit, and it is evident that the operation will be sooner or later necessary, it should be done on the field at once, or, in civil life, as soon as the patient comes under care, if the existing shock is not too great; late excisions should be reserved for cases of necrosis.

Fig. 275.



Stromeier's cushion. (Mac Cormac.)

Fig. 276.



Application of Stromeier's cushion. (Mac Cormac.)

In the *after-treatment* of these exsections, great care must be taken to prevent or quickly relieve any undue constriction, which can so readily be caused in this region by a retentive dressing. Many have advised that the arm should be simply placed on a pillow, or a Stromeier cushion,¹ and that all

which there is complete functional integrity of the elbow, wrist, and finger joints, with power of elevation to a right angle with the body. Mr. Holmes's statement that "the arm can never, as it seems, be elevated beyond the horizontal line" is certainly, while true in the main, not absolutely correct.

¹ This cushion, which the distinguished surgeon whose name it bears considered the "most valuable appliance he had invented during his life," "may be described as a right-angled

attention should be directed to the controlling of inflammation, while others have used a bracketed splint; but very satisfactory immobilization can be made by the application of a plaster-of-Paris roller, up and down over the external and posterior surfaces of the arm, extending it above and below so as to fix the scapula and forearm; with this form of dressing, strangulation cannot take place. What would be, in large numbers of cases, the results under antiseptic treatment, is, at present, a matter of inference. Reyher, at Kars, lost three out of eleven cases (27.27 per cent.), but of his five primary cases treated antiseptically from the beginning, none died, the three deaths occurring among the six patients who were not at once brought under the influence of antiseptics, and who were operated upon in the intermediary or secondary period. From such a limited number of operations, of course, no general conclusions can be drawn as to the value of the antiseptic method and the necessity of its adoption. With as much or more propriety, the English Crimean statistics might be held to show that the success of shoulder excisions is greater when antiseptics are *not* employed, since of eight primary operations recorded during the second period of that war, only one died (12 per cent.), and of five secondary operations, none—being a total of thirteen cases with only one death, a mortality of but 7.7 per cent.

EXPECTANT TREATMENT.—From the earliest times, there have been reported occasional recoveries from shoulder wounds in which no operative interference was employed. Much attention has been lately directed to such treatment by “expectancy,” and the opinion has been held by many experienced surgeons, especially among the Germans, that it is quite as likely to be followed by recovery as either excision or amputation; and some have even gone so far as to declare that the “end-result” is a better one, the limb being more useful. Statistically, it would appear from Otis’s investigations that the death-rate may be placed at about one-third;¹ but the value of such a statement, in determining the acceptance or rejection of this plan of treatment, is very much lessened when it is remembered that, as a rule, it has been adopted only for the less severe injuries.

“An attempt to establish direct numerical comparisons between the results of expectant treatment, excisions, and amputations, after shot fractures of the shoulder, would probably be undertaken only by some sciolist or dabbler in statistics, since the injuries involved are so variable in nature and extent, that the terms of comparison cannot be fairly ascertained, and any strict application of the numerical method is impracticable.” (Otis.)

In civil life, in which the wounds are almost always produced by missiles which are smaller, and which move with less velocity, than those causing the lesions met with in time of war, the expectant plan may be adopted with greater prospect of success; but even in cases of small-ball fractures, there is much danger of the occurrence of secondary hemorrhage, or of the development of general septic infection. Associated fracture of the scapula or clavicle, or both, if not very extensive, will not contra-indicate the adoption of a conservative course of treatment; and in the somewhat rare cases of joint injury

isosceles triangle, four inches thick at the apex, which rests against the chest and supports the elbow, the forearm being bent at a right angle with the arm. The cushion gradually thins down till the base is a mere edge, and of the two other angles, one is passed up into the axilla, while the other rests on the chest under the wrist. The cushion is readily fastened in its place by a tape round the neck, and one round the body.” (Mac Cormac.)

¹ In our war there were 505 cases with 139 deaths, or 27.52 per cent.; collected from various European writers on military Surgery, 185 cases with 90 deaths, or 49.73 per cent.; total, 690 cases with 229 deaths, or 33.18 per cent.

without osseous lesion, it is of course the method that should be at first selected.¹

Even if after some weeks exsection should be rendered necessary, the result, it would appear from the statistics previously given, would not be in any great degree worse than if it had been primarily resorted to. Unfortunately, however, during the period in which, if it can possibly be avoided, no operative interference should be allowed, a considerable percentage of the more seriously injured patients who have been expectantly treated, die, while many of them doubtless might have recovered had an early operation been practised. But as amputation, as the result of extended experience, gave place to excision as the proper measure to be adopted in the graver cases of shoulder wound, so future observation may lead to the substitution, for either, of the skilful aiding of nature in her efforts at restoration. Such a report as that of Beck's, who saved twenty-six out of twenty-eight cases (one dying of tetanus, the other coming under treatment only when in such bad condition as to be no longer a proper subject for any operation), is certainly very encouraging; particularly so if, by the adoption of an antiseptic course, early healing can be secured and wound infection prevented, in considerable part, if not wholly. When expectancy is tried, the ordinary measures for the maintenance of rest of the part and of the fragments, and for the securing of thorough drainage, must be adopted here as everywhere else. As Beck has written:—

By absolute rest, appropriate position, and corresponding bandages; by immobility; by constant application of cold; by an antiphlogistic regimen; by incisions (extended, in cases of severe tension of the capsule with threatening suppuration, even into the synovial sac, for the purpose of allowing the accumulated fluids to escape); by well timed opening of burrowing abscesses; by extraction of loose splinters or fragments; by the administration of opium; by subcutaneous injection of morphia in case of severe pain—the course of the injury may frequently be controlled, and even a cure with usefulness of the limb, though comparatively limited, may be accomplished.

Anchylolysis may be expected to take place when the comminution and the necessary removal of fragments have not been very extensive, but freedom of movement of the scapula much lessens the resulting impairment of the functions of the arm. Stiffness of the joint, in greater or less degree, will almost certainly attend the cure; and even in many of the peri-articular injuries, false anchylolysis from contracted cicatricial bands will occur.

GUNSHOT INJURIES OF THE ELBOW.

Like those of the shoulder, wounds of the *elbow-joint* may be either accompanied or unaccompanied with fracture; and in cases of the former kind, which are by far the more numerous, all the bones of the articulation may be injured, or only some of them. Peri-articular wounds and contusions commonly cause very decided synovial inflammation, but it becomes suppurative only after opening of the membrane by ulceration, by gangrene, or by injudicious surgery. Cicatricial contraction and muscular shortening usually cause more or less false anchylolysis; and nerve lesions, primary or inflammatory, may lead to the development of neuralgia, and may contribute in no small degree to the production of the commonly occurring muscular atrophy, which is due in part also to disuse. A severe contusion, because of both its immediate

¹ Among the 84,000 and more gunshot wounds of the upper extremity reported during our war, there were 225 cases of joint wound without fracture 72 of these being of the shoulder; of these 6 died, or $8\frac{1}{2}$ per cent.

and its ultimate effects, is certainly a graver lesion than such a perforation as is met with in the majority of cases. Though usually the diagnosis of penetration is readily made, it is at times very difficult, or even impossible, to ascertain positively that the joint has been opened, without such an exploration as it would be improper to make. The *prognosis* of elbow shot-wounds is not specially grave, as far as life is concerned, the mortality being only about 20 per cent.; but as respects the functional value of the limb, it is far otherwise. Here, again, three methods of *treatment* are to be selected from, amputation, excision, and expectancy.

AMPUTATION, as a primary operation, is clearly and unquestionably indicated only when there has been great destruction of the part by impact of a

Fig. 277.



Shot perforation of right humerus at lower third. (A. M. M., Spec. 4109.)

large projectile; or when, in addition to the fracture, there has been laceration of the brachial artery and the radial and median nerves, an ulnar-nerve wound being of comparatively little importance. When the artery only has been injured in connection with fracture of the humerus, surgeons generally are agreed upon the advisability of amputation; but some, such as Legouest, do not regard the operation as "always indispensable." The correctness of this opinion is still to be proved. "Löffler's assertion that surgical literature has not presented an example of recovery [with preservation of the limb] from shot fracture of the humerus with division of the brachial, remains uncontradicted." (Otis).¹ Again, when there has been extensive comminution of the humerus produced by a bullet, and the splintering extends so far up into the shaft that the broken portion cannot be taken away with a reasonable prospect of preserving an useful arm, the limb should be removed; since an attempt to save it will very probably end in the patient's death from septic infection, or in disarticulation at the shoulder at a time when the individual is in very

poor condition for any operative interference. In all other elbow-wounds, the choice lies between excision and expectant treatment.

EXCISION OF THE ELBOW, from which in cases of gunshot injury so much was expected a quarter of a century or more ago, has certainly in large measure failed to accomplish what is desired, the preservation both of life and of a serviceable limb. Practised in any of the ways adopted in cases of disease, but generally by the straight posterior incision, it may be either *complete* or *partial*, all the articulating surfaces being removed, or only those which are actually damaged. It has been generally believed that a complete was decidedly preferable to a partial excision, being attended with less risk, and giving a better result as regards the usefulness of the preserved limb. Such was Otis's opinion, and yet it would appear that the mortality in our war was 2 per cent. greater, and, taking together the four German wars and our own, $2\frac{1}{3}$ per cent. greater when the whole joint was excised than when only a part of it was removed (22.91 as against 25 per cent.; 23.07 as against 25.50 per cent.). The percentage of good "end-results" was, however, 2.25 in favor of the complete operation. *Primary* excisions have resulted fatally in 21.59 per cent. of cases (84 out of 393), a mortality decidedly less than that of the *intermediary* (29.26 per cent.), and that of the *secondary* (28.48 per

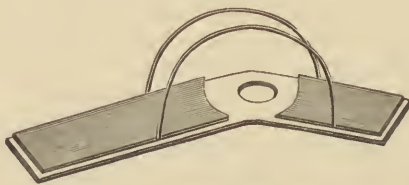
¹ In the very remarkable case under the care of Dr. T. Curtis Smith, in which the joint was extensively fractured with laceration of the brachial artery, the upper part of both ulnar and radial arteries, and the ulnar and median nerves, the articulating extremity of the humerus was laid bare but not broken. Excision was in this case successfully resorted to.

cent.), though the death-rate of a few (14) *late* operations (which were, undoubtedly, practically for disease, and not for injury) was zero.

In our war, immediate exsection was slightly more dangerous (1 per cent.) than primary amputation in the lower third of the arm, and very much more so (8.1 per cent.) than removal in the upper third, though nearly 3 per cent. less fatal than that operation when required by elbow-wounds. After extensive investigation, Dr. Otis was compelled to write: "Although the point is open to argument, I fear that the substitution of this resection for amputation effected no saving of life;" and the average mortality of the more recent operations during the Franco-German war was even greater than that presented in Dr. Otis's Surgical History.

EXPECTANCY.—In the cases treated by expectation during our late war, 938 in number, death resulted in but 10.3 per cent. (96). This statistical statement is, however, of little value in determining the proper method of treating elbow fractures, since it was only in the less serious cases that no operation was employed; had it not been so, American surgery would have proved beyond question the superiority of expectancy. As it is, there has been for years past a growing feeling in favor of this method, when removal of the arm is not evidently necessary, and a conviction, as Lücke has said, that "a large proportion of shot injuries of the elbow-joint may be treated conservatively, that is, without any operation whatever." Of seventy-seven cases under the care of eighteen surgeons, during the war of 1870–1, only six died (8.6 per cent.). That a successful result may be secured, if "Listerism" is not carried out, there must be removal of all detached splinters, thorough drainage of the joint-cavity, immobilization of the limb (which may be well effected by using an Esmarch's bracketed splint (Fig. 278) having an elbow angle

Fig. 278.



Esmarch's bracketed elbow splint.

of 130°), and moderation of inflammation. The free laying open of the joint, which has by some been recommended as a measure of prevention, should not be resorted to, unless necessary for the securing of a ready outflow of pus.

If life is saved, and secondary excision or amputation does not have to be adopted—and one of these has unfortunately heretofore been required in a large number of cases, perhaps a third of all those treated by expectation—what is the after condition of the limb, and how does its usefulness compare with that of one in which there has been a primary exsection? Very seldom has recovery taken place with preservation of the motions of the joint, and not very often with no other functional impairment than ankylosis in good position. Even though flexion and extension are lost, pronation and supination may remain, if the radius is uninjured and if only one of the other bones has been broken. Muscular atrophy follows, sometimes in high degree, and there may be persistent neuralgia. As a rule having not very many exceptions, the arm that remains after gunshot wound of the elbow which has been treated expectantly, is functionally a much damaged one.

How is it after excision—an operation which in civil life, and when per-

formed for disease, succeeds admirably? In nearly one-half of Gurlt's cases (45 per cent.), the individuals were, years later, altogether unable to support themselves. In only three out of every ten (104 out of 355), could active movements be fairly well made, and could the other joints, particularly those of the fingers, be said to be in perfect condition. In more than seven out of every ten (251 out of 355), there was either a "dangle-joint," or such a fixed twist of the arm that the usefulness of the hand was greatly impaired, or an ankylosis at a very obtuse angle (189); or muscular paralysis, or deformity and stiffness of the other joints, especially of the hand (51); or such persistent pain as to make the arm worse than useless (11). Of the primary excisions, only one in five was followed by a favorable result, and of the secondary, only three in ten; while of the very late operations, which much resemble those for disease, more than one-half ended well.

Ankylosis, which is, of course, much more likely to follow partial than complete excision, if it is uncomplicated and takes place at a good angle (from 90° to 130°), leaves a very useful arm. Through fear of an exceedingly loose joint, many, especially of the Continental surgeons, have directed their efforts to the securing of an immovable elbow; and of the two conditions of the part, the latter, if the forearm and arm are relatively properly placed, is much the better. But in more than half of Gurlt's cases of movable joint, there was no flail-like condition; and in many of the anchylosed limbs, if passive motion had been instituted as soon as suppuration became much lessened, or as soon as it could be employed without the patient experiencing much pain, and had it been kept up long after cicatrization was completed, there can be no question but that a very valuable, movable joint would have been secured, and muscular atrophy largely prevented. This atrophy, which especially affects the muscles of the arm, and of these the triceps most extensively, depends, in part at least, upon disuse; and, if in the operation the muscular insertions have been respected, by beginning passive motion as soon as it can be safely permitted, and by allowing active motion as early as it can be made, the wasting will certainly be in no small degree controlled. Expectation results badly; so does exsection. Nothing but future observation, on a large scale, can determine which is the preferable mode of treatment. What shall be done with gunshot wounds of the elbow, is one of the vexed questions which will demand consideration in the next great war, wherever it may be waged.

GUNSHOT INJURIES OF THE WRIST.

Gunshot wounds of the *wrist*, decidedly more frequent on the left than on the right side, are almost always attended with fracture; are much more dangerous, as far as the part itself is concerned, when the ball has passed from side to side than when it has gone through the antero-posterior diameter of the joint, and are frequently associated with extensive injury to the lower end of the radius or ulna, or both, and often with severe damage to the second row of carpal bones and to the metacarpus. Great destruction of the joint and of the lower part of the forearm necessitates in military, though not so certainly in civil practice, *amputation*; an operation attended with a mortality of about ten per cent. (9.6 per cent. in the 1007 primary cases during our war). In wounds of lesser severity, the treatment may be either by *expectancy* or by *excision*; the former method, according to Otis's tables, resulted fatally in 7.6 per cent., and the latter in 13.2 per cent., of the cases in which they were respectively adopted, though there were numerous cases "treated at the outset by expectation, in which excision or amputation was

eventually resorted to, with an excessive rate of mortality; . . . and consequently the results of the conservative, expectant plan are represented in a too favorable light."

An injury of this articulation, because of the anatomical structure of the damaged region, is almost certain to be followed by inflammation of high grade, attended by great pain, and extending through and beyond the carpus, unless tension is prevented or very promptly relieved. Suppurative synovitis of the tendon sheaths, which is so apt to occur, may be expected to give rise to destructive inflammation of the connective tissue planes of the forearm, and of the like tissue in the palmar subfascial bursa, unless judicious treatment be adopted, and not seldom will do so in spite of treatment. If no operative interference be required, the use of the usual remedial measures already referred to in connection with joint-injuries in general—rest, cold, position, etc.—must be thoroughly carried out. Much suppuration and delay in healing may often be prevented, and the chances of recovery correspondingly increased, by at once removing carpal bones which have been extensively shattered. Such an operation can hardly be considered a formal excision, although cases thus treated have been so included by some authors. At most it is but an excision *in*, not *of*, the articulation.

Primary hemorrhage from one of the large vessels is not a bar to the adoption of conservatism, as it may be controlled by the application of a ligature; and secondary bleeding, which at times occurs, may generally be arrested in the same way. Ankylosis of the wrist takes place in the great majority of cases which recover, but it is a matter of comparatively little importance if the finger motions have been preserved. Every care should be taken, by the selection of position and by moderation of inflammation, to prevent adhesion of the flexor and extensor tendons to their sheaths; and early but judicious, passive, and at a later period active, motion should be made, in order to preserve, if possible, the finger movements, without which any saved hand is of little functional value. When formal excision is adopted, it should be by lateral incisions, as in the method of Lister, or by the dorso-radial, straight incision of Langenbeck; the cut across the dorsum is proper only when the missile has already divided the tendons. The lower part of either radius or ulna alone should not be removed, since after recovery the hand is almost certain to be deflected laterally, at times

Fig. 279.



Deformity following removal of fragments from comminuted gunshot fracture of radius. (A. M. M. Spec. 2671.)

Fig. 280.



Deformity following excision of lower portion of radius. (McDermott.)

even to a right angle (see Figs. 279, 280); if only one of the two bones is damaged, the lower end of the other should be equally excised, in order that a straight position of the hand may be secured. Decided advantage

has been found to result from continuous extension by adhesive straps and weights, the forearm being maintained in a somewhat supinated position.

In nearly one-tenth of Gurlt's cases (9.6 per cent., 12 out of 125) amputation was ultimately required; and one-half of those thus operated upon died. The death-rate of all the resections was 16 per cent. (20 out of 125), pyæmia being, as in the cases treated by expectation, the chief cause of mortality. As respects saving of life, removals of the radius and carpal bones have given the best results, all of the eight cases recorded having ended in recovery; and removals of the lower ends of the bones of the forearm with the carpal and metacarpal bones have given the worst, two out of the five persons thus operated on having died (40 per cent.). When the wrist-bones in part or whole are taken away, there is, it would seem, a most marked difference in the death-rate according as the ulna is or is not removed, the percentage being in the former case from 20 to 40, varying with the bones removed. Whether or not this has been in the observed cases simply accidental, or really consequent upon the removal of the ulna, future experience must determine; it may perhaps be a significant fact that, when only the lower end of the ulna has been excised, the fatality has been more than twice that of similar operations upon the radius (19.23 per cent.; 8.1 per cent.).

Although, as has been shown, the average mortality of wrist-wounds treated by excision is double that following expectancy, yet, as cases of the latter class are, as a rule, of decidedly less gravity than those of the former, the real question to be settled is which gives the best ultimate result. That of expectation is certainly not satisfactory, as far as the functional value of the saved hand is concerned; ankylosis, deformity, more or less stiffening of the fingers—such is the condition reported as existing in the great majority of cases; but, on the other hand, the same is true of excision:—

“In sixty-eight of the ninety-six patients whose hands were preserved, at least in part, fifty-one had ankylosis at the wrist, five mobility with deformity, and three dangling-joints. Nine, of whom two are still in service, are reported to have had comparatively useful limbs.” (Otis.)

Gurlt says that of the 72 American cases which he has tabulated, in only three were the results in “any way good;” and that of the sixteen German patients, but one had a good arm and hand, while in eight cases the parts were but tolerably useful, in six they were bad, and in one worse than useless. As a whole, the results were “very unfavorable.” It would certainly seem that the proper treatment of wounded wrist-joints, when there is not such complete smashing as to compel immediate amputation, is by expectation—that is, by removing fragments, immobilizing the forearm and hand, securing drainage, moderating inflammation, opening abscesses, employing antiseptics, and, as far as possible, preventing stiffening of the fingers—and not by formal excision, either complete or partial.

GUNSHOT INJURIES OF THE HIP.

Of much greater severity than those of the corresponding joints of the upper extremity, are gunshot wounds of the hip, knee, and ankle. Injuries of the *hip-joint* may be either penetrating or non-penetrating. The overlying soft parts may be simply contused, or the ball in its passage across it may bruise the capsule, or there may be a wound of the femur with splintering up to, but not into, the intra-capsular portion of the neck. In all of these latter conditions, when there is subsequent involvement of the joint itself, synovial inflammation takes place—frequently, but by no means always,

suppurative in character—with, ordinarily, rupture of the capsule at a later period, burrowing of pus, and, if death does not previously occur, formation of sinuses. Caries at times is developed, or a condition of the head and neck of the bone similar to that observed in chronic rheumatoid arthritis. In the penetrating wounds, there may be perforation or lodgment of the ball; limited or extensive shattering,¹ the fissures running, it may be, through the trochanters, or far down the shaft; fracture of the acetabulum or other part of the innominate bone, or penetration of the pelvic cavity with or without visceral lesion; wound of the neighboring great vessels or nerves; or associated through distant injury of, at times, the same extremity.

Fig. 281.



Upper end of left femur perforated by conoidal ball. (A. M. M., Spec. 563.)

DIAGNOSIS AND PROGNOSIS.—Difficult as is often the diagnosis of a wound of any joint, it is especially so in the case of the hip, positive evidence in the escape of synovia, digital exploration, or the severity and character of the after-symptoms, alone sufficing to establish it. The left hip is much more often wounded than the right, no doubt because of its more advanced and exposed position in firing. The mortality of these wounds is excessive. Of 349 which occurred during our war, 297 died (85 per cent.); and in all probability, were the cases of recovery in which a mistake was made in diagnosis (no penetration having taken place) eliminated, the death-rate would be found to be nearly or quite 95 per cent., the fatal issue being due in most instances to shock, visceral wound, exhaustion, or septic infection.

TREATMENT.—Expectancy, excision, and disarticulation, are all but doubtful remedies for a desperate condition. Hip-joint *amputation* (which should be employed, if at all, only when there has been great destruction of the part, or wound of the main vessels or nerves, or associated fracture lower down), had prior to 1870 resulted fatally in 29 out of 31 cases in which it had been performed for intracapsular wound, that is, in 93.5 per cent.; and it is probable that in the large majority of these cases, the operation only hastened death.

Excision, first adopted in shot-wounds of the hip but a little more than half a century ago (by Oppenheim, in 1829), and done but twelve times in all up to 1861—two of these operations, moreover, having been at a late period, for caries—has resulted fatally in 90.6 per cent. of the cases in which it has been performed for joint-wound (106 out of 117). But not one of Reyher's three cases antiseptically treated proved fatal, and in the future, the adoption of some method to render the operation wound aseptic, may very materially diminish the mortality. Even if it should not, there can be no question but that the removal of the broken bone and drainage of the cavity greatly contribute to the comfort of the patient, while he does live; and if recovery takes place, it is with a quite useful limb, notwithstanding its being more or less shortened; the result is functionally better under these circumstances than that of similar operations done for disease. All of the 15 individuals successfully treated were able to use the leg more or less perfectly, and to make a living. As the result of a secondary excision done by Surgeon J. R. Gibson,

¹ In a case operated upon by Surgeon Clements, U. S. Army, the cervix femoris was found broken into about forty pieces.

U. S. A., in 1868, the man three years later "could walk almost as well as ever." Dr. Mursick's patient, four and a half years after an intermediary operation, could perform all the movements of the thigh "with almost as much facility as in the normal state—rotation, even, as well as flexion, extension, adduction, and abduction. His general health was good. He still worked as a day laborer."

In the present state of knowledge, it certainly seems the part of wisdom, in cases of hip wound, to make an exploratory incision as soon as possible, and, if the damage has not been such as to preclude any reasonable hope of doing good, to excise the broken bone. No benefit can be derived from leaving, as has been done, an uninjured femoral head in the acetabular cavity, when the neck is taken away; necrosis would certainly follow. Ordinarily, the long, straight or angular incision, from above downwards, along the posterior border of the trochanter major, will be found most convenient. If the patient must be moved, the joint should be immobilized; but if he can be treated at the place of operation, the dressing may be conducted according to any one of the several methods which are employed in civil practice after excision for disease.

GUNSHOT INJURIES OF THE KNEE.

Of more frequent occurrence, and of hardly less gravity, than wounds of the hip, are those of the knee-joint, which may be either penetrating or non-penetrating. The latter undoubtedly occur, oftentimes, when the apparent line of direction of the shot lies through the articulation, the missile having been deflected by the periarticular structures;¹ and the joint proper may not be opened, even though the patella has been broken, or the head of the tibia bored through. Such a tibial perforation, which is not very seldom seen as the effect of a round ball, may be caused by the passage of a pistol bullet, and, though not very often, even by that of a conoidal musket-ball—the chassépot bullet being the only one used in the Franco-German war which produced such an injury in the cases observed by Becher. Usually, whether the shot has passed through or lodged, there is associated fissuring, and, if not primary, at least secondary opening of the synovial pouch, in which case violent symptoms of joint injury may not manifest themselves until several days after the receipt of the wound.²

Penetrating injuries, whether made by small or large bullets, are in a high degree dangerous, not only to the part but to life itself, the usual gravity of lesions of the knee-joint being greatly increased by the more extensive damage which is always characteristic of gunshot wounds.

EXPECTANT TREATMENT.—Until recently, the expectant treatment has resulted badly, except when the vulnerating body has been of small size, its removal easily effected, and the bone-splintering limited; and when circumstances have permitted of most judicious care under favorable personal and hygienic conditions. "In no single instance during the Crimean war" (ac-

¹ MacCormac reports that he had under his care, during the Franco-German war, twenty-one such cases, of which only two proved fatal.

² A typical case, in which a soldier was accidentally shot with a small revolver-ball in the street of Balaklava, was reported from the Crimea. "The missile had embedded itself in the tibia, just below its tuberosity, whence it was easily turned out by a pointed instrument, after a small incision had laid the site open. The knee-joint did not appear to have been involved, but the man died eight days afterwards from the effects of acute inflammation of it, and the accompanying sympathetic fever. On examination after death, a minute fissure was found to have extended through the head of the tibia into the joint." (Matthew.)

according to Longmore), "was a knee-joint, which had been opened by a bullet, saved, life being lost in every case where amputation was not resorted to." By the official "Medical and Surgical History of the British Army" in the Crimea, however, it is shown that eight cases were saved without operation,

Fig. 282.



Partial fracture of left femur by conoidal ball lodged in cancellated structure. (A. M. M., Spec. 4071.)

Fig. 283.



Amputated end of right femur and head of tibia with round musket ball impacted in latter. (A. M. M., Spec. 1481.)

though in none of them was the bone within the capsule "more than grazed (not fractured)." Of 308 cases treated by expectancy during our war, 258 (83.76 per cent.) died, and it is believed that even this does not truly represent the excessive mortality, cases of non-penetrating wound probably having been, by error of diagnosis, included among the 50 that recovered. Of 529 cases similarly treated in the Franco-German war (and reported upon by Heintzel), 334 (63.14 per cent.) died—225 of these after subsequent amputation, which was employed in 288 cases, or in 54.4 per cent. of the whole number which it was attempted to treat expectantly. Of the entire 529 cases, only 132 (25 per cent.) recovered with a fairly useful limb. Of Reyher's 19 cases, 18 died (94.7 per cent.). On the other hand, during the war of 1866, out of eighteen cases of gunshot wound of the knee, eleven were cured by conservative treatment (61.11 per cent.). Extensive opening of the joint by a shell fragment is more likely to be followed by recovery than is a bullet wound. Such injuries, if not fatal, are usually followed by ankylosis.

AMPUTATION AND EXCISION.—Until within the last ten years, the results following *amputation* were better than those obtained by expectation, but the mortality rate was still very high, especially when the operation was performed in the intermediary period. Of 452 determined cases, during the war of the Rebellion, 331 died, or 73.23 per cent. *Excision* of the knee, which has been adopted 134 times in military practice, has been followed by death in 108 cases, or 80 per cent., and unless the antiseptic treatment should in the future very greatly lessen this mortality, the operation should certainly be, as Sarazin has put it, "proscribed in army surgery." In civil life, it succeeds much better, as might naturally be expected, since the injuries are as a rule less extensive, being made by smaller projectiles, and since the after-

treatment can be more satisfactorily carried out. Of twelve such cases, tabulated by Gurlt, only three died (25 per cent.). It would appear from the investigations of the writer just quoted (though his conclusions are based upon only 28 cases), that if the patient does not die, he will probably recover with an useful limb—the “end-result” of this excision being better than that of any other except the hip.

But while, prior to 1876, under any one of the three methods of treatment, gunshot wounds of the knee, in time of war, resulted fatally in more than two-thirds of the cases, the reports that have been given of the recent attempts at conservation, under antiseptic treatment, would seem to indicate that the mortality can be very much lessened. Of Reyher's eighteen cases, antiseptically treated from the first, only three died (16.66 per cent.), and twelve of these which were treated by occlusion, all recovered, each with a movable joint. Of his 40 cases which were only secondarily rendered antiseptic, 34 died (85 per cent.). Of Bergmann's fifteen cases treated early, but one died (6.66 per cent.); of his fifty-nine cases in all, only 24 died (44.5 per cent.); and of the thirty that recovered, twenty-eight preserved their limbs.¹ Of four non-military cases treated at Halle, all got well, and in three there was good motion of the knee (Kraske).

Even very considerable splintering has not prevented rapid recovery with preservation of the function of the joint. Unless future and extended experience shall show that such favorable results are but exceptional, knee-joint wounds hereafter must be treated conservatively and antiseptically, if the extent of the injury be not so great as to necessitate immediate amputation; for it would certainly seem as if Reyher was right in declaring that “under primary antiseptic treatment, the injury loses its danger for life and limb of the patient. The prognosis is better, and to this must be added the assurance with which a prognosis can be made.”

Fig. 284.

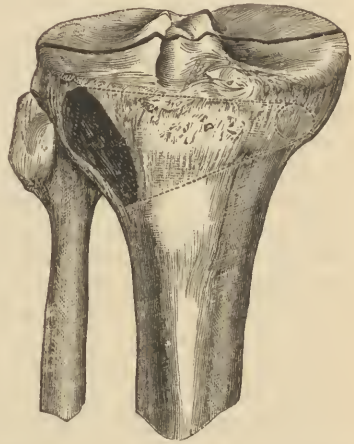


Diagram of gunshot wound of tibia with fissure entering knee-joint. (Kraske.)

GUNSHOT INJURIES OF THE ANKLE.

As in wounds of the other joints, so in those of the ankle, the articulation may or may not be opened. The periarticular injuries, which usually involve the parts behind the joint—seldom those in front—not infrequently cause severe hemorrhage, primary or secondary; may be associated with lesion of the posterior tibial nerve; and are often followed by stiffness of the ankle from cicatricial contractions, and by deviations of the foot from shortening of tendons, the result of loss of substance or of inflammatory adhesions. The

¹ Bergmann's dressing was from necessity quite a simple one: “As soon as possible after the wound had been inflicted, the vicinity of the spot where the shot had penetrated was cleansed, then the whole limb was wrapped in a thick layer of antiseptic cotton-wool, the latter firmly pressed down by means of an elastic bandage, and the whole, including the ankle and hip-joint, embedded in plaster of Paris, and allowed to remain undisturbed for a fortnight or more. In some cases the first application of this dressing sufficed to effect the healing of the cutaneous wound.”

penetrating wounds are much more frequently caused by the passage of a ball laterally than in the antero-posterior diameter, so that malleolar fracture is commonly seen either on one or both sides, and, if only one, generally on the outer. Escape of synovia in moderate amount, without other associated evidence, cannot be held to certainly indicate opening of the articulation, since wounds of the sheaths of the tendons may be followed by a similar discharge.

TREATMENT.—The treatment of these ankle-wounds must be conducted upon the same general principles as those already considered in connection with injuries of the wrist, the analogous joint of the upper extremity. When the destruction has been great, as from a large shell fragment in military life, or from a load of shot at short range in civil practice, even if one of the main vessels and nerves be undamaged, amputation may very properly be performed, since the danger of the operation to life will be at least no more, while recovery will be quicker—and by the adaptation of an artificial foot the functional value of the limb will be fully as great, if not greater—than when conservative measures have been successfully adopted. Under all other circumstances, every effort should be made to preserve the foot, the usual details of the treatment by *expectancy* being fully carried out. Not only should all foreign bodies be removed, but the gouge may be freely used along the shot track through the bone or bones, and if necessary for the proper drainage of the wound, a malleolus may be cut away. Extensive destruction of the tendo-Achillis does not, as has by many been thought, contra-indicate the attempt to save. In the immobilization of the part, much care must be taken to keep the foot at a right angle to the leg, to prevent the production of the “pointed toe” that so much interferes with the after-usefulness of the limb; and suppurative teno-synovitis, which is very likely to occur, must, if possible, be prevented. Almost certainly, ankylosis will take place, and such a termination is really the most desirable. But recovery in the great majority of cases of penetration, certainly of those treated otherwise than antiseptically, takes place only after the lapse of many weeks, and the results of the protracted confinement and suppuration may be such as to compel the performance of either excision or late amputation.

Primary excision has been very rarely if ever performed for gunshot injury of the ankle, so that in this joint excision may be regarded simply as the complement of expectancy. Its results have not been such as to make it a favorite operation with military surgeons. Of the 142 cases tabulated by Gurlt, 49 ended fatally (35.5 per cent.), and in 19 cases an after-amputation was required, with a resulting mortality of 63.15 per cent. Death, according to Culbertson, may in one-sixth of the cases be attributed directly to the operation itself. Of the patients who recover, about one-half (52.72 per cent. of the 55 Germans in whom Gurlt was able to ascertain the “end-result”) may be expected to have a fairly useful limb, and this whether the resection be complete or partial. If only one of the leg bones has been involved in the excision, lateral deviation of the foot will almost certainly take place. The operation, if done at all, should be effected by means of lateral incisions. The duration of treatment in successful cases is to be estimated by months, not weeks.

In contrast to the death-rate of excision (35.5 per cent.), that of ankle-joint *amputation* is low (13.43 per cent. in the 67 cases tabulated in “Circular No. 6”); that of supra-malleolar amputation “surprisingly low” (Otis); and that of leg-amputation in general, while quite high—26.02 per cent. (Otis)—still nearly ten per cent. more favorable. Even compared with Legouest’s statis-

ties, excision is more dangerous by 12.5 per cent. than amputation at the joint, though less so by 13.5 per cent. than removal through the leg; but Legouest's figures, here as elsewhere, are largely those of the operations performed by the French surgeons in the Crimea, the fatality of which was excessive.

GUNSHOT INJURIES OF THE HEAD.

Gunshot wounds of the head may be confined to the *scalp*; may also involve the *cranial bones*; or may present, in addition, an injury of the *brain* or its coverings, with or without lodgment of the missile.

SCALP.—When the scalp alone is damaged, there may be only *contusion*, which, if severe, is almost certain to be followed by cerebral disturbances; or simple *division*, differing but little from an incised wound, an accident due almost always to the superficial impact of a shot passing at a high rate of speed; or, what usually occurs, a more or less deep *grooving* with primary or secondary loss of substance; or, and this is frequently observed, a *seton wound*, sometimes of considerable length; or, lastly, *penetration with lodgment*, often seen in wounds produced by small shot or pistol bullets of small diameter, and at times in those caused by nearly spent rifle-balls. Ordinarily recognized without difficulty, the scalp injury may, for a time, escape detection when the shot has passed up to the head from the neck or face.

The *prognosis* is favorable; the mortality is only 2 per cent.¹ chiefly from "some form of encephalitis," though the various wound-complications may occur, particularly hemorrhage; and though cerebral disturbances, occasionally very persistent, are not unlikely to follow injuries inflicted by missiles of large size. Primary union seldom occurs, though much more apt to take place here and on the face than in superficial wounds in other parts of the body.

Treatment.—If a bullet has lodged, its presence can be detected without difficulty, except when located in the temporal fossa; its position then may be indicated only by pain on moving the lower jaw. Bird-shot, and even small pistol-balls, may be so flattened and buried in the tissues as not to be discovered upon palpation, or by the use of the probe. If found, the foreign body is to be removed through either the original wound or a counter opening; but when very small, no extensive search should be made, as the offending substance will probably reveal its presence at a later period, or will otherwise remain innocuous, causing no material delay in the healing of the wound. *Seton wounds* not infrequently convert themselves by sloughing into deep *grooves*; and because of the possibility of such a change being produced, some have advised that they should be early laid open, a procedure, however, that, as a rule, should not be adopted, since in very many cases, when left alone, the bullet track readily heals. As the result of a shell wound, there may be an extensive loss of substance, with or without exposure of the bone.

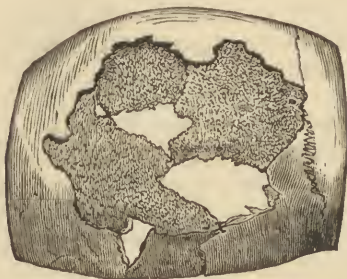
The treatment of scalp wounds is that of ordinary flesh wounds elsewhere, though in cases in which there has been produced scarcely more than an *incision*, sutures may be very advantageously employed, primary union being not infrequently thereby secured; and in the cases of *grooving* the introduction of stitches does no harm, and often by holding the edges closer together lessens the time required for healing. As in scalp-injuries other than gunshot, adhe-

¹ 162 deaths out of 7739 cases during our war (2.09 per cent.)*

sive straps are of little service, since they soon become loosened and slip. Hot applications at times are much more comfortable and better adapted to moderate inflammation than cold.

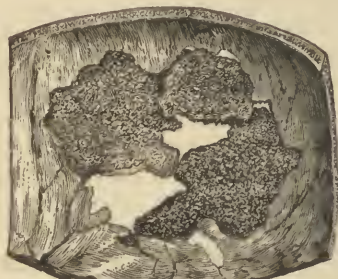
CRANIAL BONES.—Like other bones, those of the cranium may be either contused or broken; such lesions are, as a rule, more serious than when conse-

Fig. 285.



Necrosis following gunshot fracture of right parietal bone. (A. M. M., Sect. 1, Spec. 3859.)

Fig. 286.



Necrosis following gunshot fracture of right parietal bone. (Interior view.)

quent upon an ordinary blow, or fall, and are more apt to be associated with cerebral injury.

CONTUSION OF CRANIUM.—The contusion may be slight, unrecognized, and quickly recovered from, as it is likely to be when due to a small pistol-ball wound; or may be so severe as to kill at once the injured part; or may be followed by acute or chronic bone inflammation, causing subperiosteal effusion or exudation, suppurative osteo-periostitis, or necrosis—caries is rarely observed—one or all; and complicated with severe inflammation of the overlying soft parts, meningo-encephalitis, cerebral abscess, or pyæmia.¹

Not infrequently it happens that no symptoms of bone-injury show themselves for many days, when suddenly violent cephalalgia is experienced, soon followed by convulsions, coma, and death from intracranial suppuration. Very generally, however, if primary laceration of the meningeal vessels causing compression from blood-clot has not taken place, there will be experienced, after recovery from the immediate effects of the wound, it may be for a long time, headache of greater or less severity, associated in many cases with dizziness, intolerance of light and sound, nausea, and vomiting. Simple *periostitis* does not often occur, and no case of diffuse inflammation of the pericranium was reported during the whole course of our late war. *Osteo-periostitis* may be indicated by the presence of the "puffy tumor of Pott," which however is by no means always present, and by the exudation of pus through the contused bone. Purulent infection manifests itself in the usual way. At a later period exfoliation occurs, either superficial or of the external table, and, at times, separation of necrosed pieces of the entire thickness of the bone. This *necrosis* is occasionally primary, but is generally consequent upon inflammation. *Hyperostosis* or *eburnation* may, though rarely, be met with.

Chronic cerebral disturbances, more or less well marked, mental irritability,

¹ The hepatic abscesses observed long ago, without any pus collections in the lungs, are, it is probable, due to the passage of septic emboli (from thrombi in the diploic veins) from the arteries to the veins, in the lung, in which viscous, besides the usual capillary connection, there is also, as observed by O. Weber, a "direct merging of the terminal ramifications of the arteries in the rootlets of the veins."

change in the temper and habits of the individual, and epilepsy, are not rarely found as the result of these injuries. Judging from the cases reported by Otis, one in six of cranial contusions from rifle-bullets and shell-fragments may be expected to cause death;¹ and, speaking generally, these contusions when severe are more serious than fractures, the breaking of the bone in a measure protecting the brain and its coverings, lesion of which is the chief element of danger in all head injuries.

Treatment.—When contusion is known to have occurred, the maintenance of rest is of the utmost importance, and, if symptoms of internal inflammation show themselves, cold should be applied, either by ice-bags or by a coil of rubber tubing (the mediate-irrigation coil of Petitgand). Subperiosteal

Fig. 287.



Mediate irrigation; coil applied to head. (Petitgand.)

suppuration occurring, the pericranium should be incised, and if the exposed bone is discolored, porous, and exuding pus, it should be opened with a small saw or trephine; often the external table only, in the latter case, requires to be removed. In a word, cranial suppurative osteo-periostitis should be treated in the same way as the corresponding affection in a long bone. If the early occurrence of compression makes it probable that there has been extensive hemorrhage from a ruptured sinus or meningeal vessel, the trephine should be used, so that, if possible, the clot may be removed and the bleeding stopped. When later-occurring symptoms indicate that pus has accumulated beneath the skull, although "it is impossible to distinguish intracranial suppuration from arachnitis" (Ashhurst), and although the result of complete trephining in gunshot contusion has been very unsatisfactory—all of the twelve cases thus treated during our war having proved fatal—yet, as the condition if left to itself is almost certain to cause death; and as the simple removal of a button of bone with a conical trephine can only do harm by the resulting admission of air, while such harm can be greatly or altogether prevented by antiseptic after-treatment; and as evacuation of pus may relieve the symp-

¹ Of three hundred and twenty-eight patients with gunshot contusion of the cranial bones, fifty-five, or seventeen per cent., died; ninety-eight, or thirty per cent., were disabled from causes referable to injuries of the head; and one hundred and seventy-five, or fifty-three per cent., recovered.

toms and save the patient, there is certainly good reason why in these cases operative interference should be attempted.

Fig. 288.



Perforation of skull by conoidal musket ball. (A. M. M., Sect. 1, Spec. 5473.)

Fig. 289.

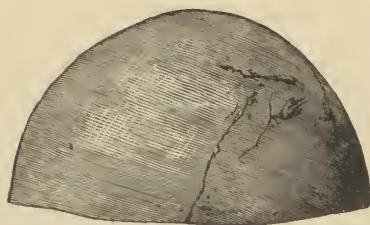


Shell fracture of skull. (A. M. M., Sect. 1, Spec. 2871.)

FRACTURES OF CRANIUM.—These, as consequent upon gunshot injury, may be *partial*, only one of the two tables of the injured bone giving away; or, and this is ordinarily the case, *complete*. More or less comminution is usually produced; at times limited to the immediate vicinity of the point struck, but not seldom affecting the bone over a considerable area, or even involving every part of the cranium, with or without associated separation of sutures.¹

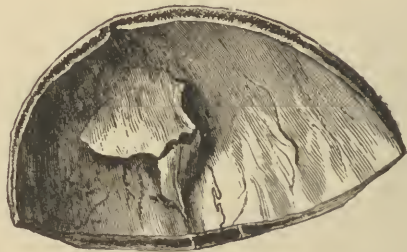
The extensive shatterings are almost always due to shell-injuries, or to perforating wounds made by rifle-balls of large size. When the force of impact is not great, only one of the tables may be broken; usually the *inner*, not because of its special brittleness, but in accordance with Teevan's

Fig. 290.



Section of frontal bone, showing fissure over left supra-orbital region. (A. M. M., Spec. 24.)

Fig. 291.



Internal view of frontal bone, showing splintering of vitreous table. (Same specimen as Fig. 290.)

law that the breaking takes place in the line of extension. Fracture of the *outer* table alone very rarely occurs (though it does at times happen) except when the injury is inflicted over the frontal sinus, the mastoid process, or the occipital protuberance.² In fractures of the lower frontal region, in children,

¹ In Circular No. 3, S. G. O., 1871, a case is reported by Assistant Surgeon Yeomans, U. S. A., in which, in consequence of a musket-ball perforation (the ball fired at a distance of 315 yards entering through the posterior part of the parietal, and emerging through the frontal bone), all of the eight cranial bones were broken, as shown at the autopsy. (Fig. 288.)

² Otis declared that he was disinclined to admit that the outer table of the skull was ever fractured in the adult, without injury to the inner table, either by projectiles of war or other external violence, except in the rare instances of blows or the impact of missiles upon the superciliary ridges, the mastoid or zygomatic processes, and possibly the occipital protuberance; or in cases of grooving by a sharp shell fragment.

both tables must almost certainly be broken, since the sinus is undeveloped until at or about the period of puberty.

Though, occasionally, fracture of both tables with greater or less splintering of the internal may occur, without depression of the outer, ordinarily the latter condition is well marked, the portion driven down being, at times, quite limited in area, and the fracture a punctured one, but, as a rule, of considerable extent and accompanied with widely extending fissures. The comminution associated with penetrating or perforating wounds is in no small degree, doubtless, due to the hydrostatic pressure developed in the traversed brain. Busch and Kocher's experiments have shown that "in firing at short distance into a skull filled with soft brain-substance, the cranial walls are broken up in all directions and widely scattered." Fractures by *contre-coup* (if such they may be named) may thus be produced by the force of a grazing or penetrating shot, transmitted through the semi-solid cerebral mass to some part of the base of the skull, as in the form of fracture met with in President Lincoln's case,¹ two examples of which have been noticed by Longmore, while six others, from the Russo-Turkish war, have not long since been recorded by Bergmann, of Würzburg—one or both orbital plates being broken, with or without associated lesion of the ethmoid bone. As indicative of the existence of such a basal injury in connection with wound of some part of the vault, may be mentioned "retrobulbar extravasation and exophthalmos, associated probably with a lesion of some of the motor nerves of the eyeball, or even of the optic nerve" (Bergmann); and, if the cribriform plate of the ethmoid has been fractured, anosmia.

The *diagnosis* of gunshot fractures of the skull, if other than linear, and if occupying the vault or sides, is usually easy—the ordinarily associated tegumentary wound permitting a ready determination by finger or probe of the existence of a break. At times, however, even when the shot has penetrated, the elasticity of the skull, aided very probably by the tension of the dura mater, and perhaps by the pulsatile force of the brain itself, may so perfectly restore the fragments to position as to make it exceedingly difficult, it may be impossible, to recognize the osseous lesion, or, still more, to detect an existing penetration with lodgment of a foreign body. In the latter case, the establishment of the diagnosis may be greatly facilitated by the possible presence of a shred of clothing or a hair, carried in by the shot and caught between the edges of the break, as in the case reported by Assistant Surgeon Howard, U. S. A.,² though a hair may be driven in by a missile which does not penetrate.³

When it is the base of the skull that has been broken, the ball having entered through the face or neck, and when the patient lives long enough to come under treatment—the nature of the injury, if recognized at all, will be so by determination of the length and direction of the track of the bullet, and by observation of the ordinary symptoms of basal fracture produced by violence other than gunshot. Escape of cerebro-spinal fluid, if it occurs, may,

¹ President Lincoln was killed by a bullet which "entered through the occipital bone about an inch to the left of the median line, and just above the left lateral sinus . . . passed through the left posterior lobe of the cerebrum . . . and lodged in the white matter . . . just above the anterior portion of the left corpus striatum. Both the orbital plates of the frontal bones were broken."

² American Journal of the Medical Sciences, Oct. 1871.

³ As in the case reported from the Crimean war, in which, an undepressed fracture of the upper part of the frontal bone having been caused by a shell-fragment, the spontaneously separated portion of the external table "contained a fissure in its centre, into which some hair had been driven and firmly impacted." (Matthew.)

as stated by Roser, be regarded as indicative of a superficial brain lesion, the swelling following deeper injuries preventing such discharge.

That the missile has lodged, may at times be ascertained by exploration of the wound, or even, in rare cases, by the detection of an elevation of bone on the opposite side of the head, the ball having partially perforated from within outward at such a point; but usually it is, during life, a matter of conjecture simply, only a single wound existing, and there being no evidence of the missile having rebounded or having been deflected after producing the fracture.

Prognosis.—The prognosis of these injuries, though much affected by the nature of the wound, is always grave; not because of the fracture itself, for a broken skull-bone heals as readily as any other, but because of associated lesions and resulting complications. Aside from hemorrhage from a lacerated sinus or meningeal vessel, and actual cerebral damage, the danger is chiefly due to meningo-encephalitis, because of the nearness of the brain, and the facility with which it participates in the lesions of its coverings. This meningo-encephalitis may be developed at an early period, or, as is more usual, after a number of days—particularly in the latter part of the second week—and is ordinarily, though not necessarily, associated with an open wound. As a result, acute suppuration may take place, a cerebral abscess having been observed by Beck as early as the fifth day, though commonly the pus-collection is either not formed, or does not produce any symptoms, until after three, four, or five weeks. When lodgment of a foreign substance has occurred, and the foreign body remains, it may prove the developing cause of suppurative brain inflammation even years after apparent recovery has taken place. In the Crimean war, 74 per cent. of the cases of cranial injury proved fatal (711 out of 961), and during our late war the mortality-rate was 59.2 per cent. (2514 out of 4243 cases the results of which were ascertained).

Fractures of the internal table alone proved fatal in nineteen out of twenty cases (95 per cent.), penetrating fractures in 85.5 per cent. (402 out of 470 cases), and perforating fractures in 80 per cent. (56 out of 70 cases). In civil life, when the injury has been inflicted by a shot-gun charge at short range, with resulting extensive local destruction, the probabilities of a fatal issue are of course very great; but even in such a case, and much more so in a non-penetrating pistol-ball wound, recovery is decidedly more likely to take place than in military practice. For this there are various reasons, such as the earlier and more constant attention that can be given in civil practice; the generally better hygienic surroundings; the less velocity of the vulnerating body, and consequent less damage to the brain; and, not least, the, as a rule, less advanced age of the patient. Young adults bear these injuries better than those in middle or advanced life, and children, who are often the subjects of accidents of this kind, decidedly better yet; and this has been especially noticed with reference to cases of splintering and depression of the internal table.

Injuries of the base are much more dangerous than those of the vault, but it would appear from Lidell's investigations that they "prove mortal much less frequently than heretofore has generally been supposed"—35 out of 137 patients having more or less perfectly recovered, and two or three of these "so completely as to re-enlist." It is generally held, with Guthrie, that a wound of the anterior part of the head is more likely to cause death than one of the posterior. But that such is the fact is by no means certain. In the 316 cases of penetration and lodgment tabulated and analyzed by H. R. Wharton, of which 279 were instances of gunshot injury, the relative mortality of

wounds through the frontal, parietal, and occipital bones, was, respectively, 44 per cent. (58 out of 132), 46.5 per cent. (27 out of 58), and 70 per cent. (16 out of 23); while the death-rate of those through the temporal bone was but 38.7 per cent. (12 out of 31), probably because of the fact that the larger proportion of such injuries never come under treatment. Wounds of the cerebellum almost always prove quickly fatal, though in a case reported by S. W. Gross the patient lived nearly five days:—

“At the expiration of forty-eight hours after the reception of the injury . . . his manner was perfectly rational . . . he complained of no pain in the head, nor suffered from special symptoms . . . his thumbs were adducted and strongly flexed in the palms, and he told us that he suffered from persistent priapism, which we found to be the case. There were no other general symptoms: the man had a good appetite, was continually walking about. . . . On the morning of the 11th (April) we found him in his tent dead, and in the supine position. The calvaria having been removed, the somewhat misshapen buckshot was seen to be in contact with the corpus dentatum of the right lateral hemisphere of the cerebellum. A small splinter of bone was lying in the track of the wound, and the morbid appearances were confined to slight ecchymosis of the cerebellum, and a small quantity of bloody serum at the base of the organ.”

In the majority of cases which do not prove fatal, more or less cerebral disturbance is likely to be experienced during the after-life of the individual; headache, irritability, inability to endure exposure to the sun, etc. Epilepsy is a not infrequent result, as is impairment of the special senses, particularly of sight and hearing. Legouest says that he has even seen two cases of immediate and irrecoverable loss of sight after injury of the supra-orbital nerve; though it is probable that such a condition was really due to either frontal fissure extending into the optic foramen, with or without intra-vaginal extravasation, or to hemorrhagic detachment of the retina.¹ Impairment of vision at a later period may be caused by plastic choroiditis. Generally, the blindness after non-penetrating injuries is unilateral; when occurring on both sides, the prognosis seems to be more favorable. Wounds of the mastoid process are very often followed by deafness, and occasionally by facial paralysis. More or less persistent, early aphasia has been not infrequently observed in injuries involving the “language centre.”² The frequently occurring primary paralysis of the extremities may become permanent in greater or less degree.

On the other hand, no damage other than that which is local and temporary may be produced, and ball and even bone may remain for years in the brain without doing any harm. Such cases, however, are but the fortunate exceptions proving the rule; and many times it has happened that, after a long period of apparently perfect health, death has resulted from the presence of the foreign body.

Treatment of Gunshot Fractures.—Respecting the proper mode of treatment of these cases, there has been and is much diversity of opinion, and, whatever rules may be laid down, individual judgment must, in any given case, largely

¹ Berlin, upon examining thirty-four such non-penetrating cases, found fractures of the walls of the orbital canal in every one. Cohn observed one case, during the Franco-German war, in which a fragment of shell wounded the right upper eyelid and brow, and caused partial blindness of the right eye. Six months later, on account of the development of sympathetic ophthalmia, enucleation of the right eye was practised, and examination showed that there were remains of a former hemorrhage in front of and behind a projecting fold of the retina, in the region of the macula.

² As long ago as during Napoleon's Russian campaign, Larrey noticed two cases of aphasia, due not to gunshot but to rapier and lance wounds, cases in which, however, the lesions did not, at least directly, affect Broca's convolution or the parts immediately about it.

determine what shall be done. Gunshot fractures of the skull differ from other fractures only in the greater probability of the meninges or brain, or both, being damaged.

If there is a *linear* fracture existing without depression or symptoms of compression, the case should certainly be treated expectantly: and yet in these very cases there is a strong possibility that there has been splintering of the internal table, and that there will be developed a meningo-encephalitis, though this latter condition is not a necessary sequence. When there is *comminution* and *depression*, without compression—and, for still stronger reasons, when pressure symptoms are present—it is certainly the part of wisdom to remove the fragments; and this can generally be done by the aid of the elevator, without having recourse to the trephine. But aside from cutting out a little unbroken bone, what added risk is there in judiciously using a conical trephine to open a way by which to get at and remove existing fragments? Notwithstanding that the use of this instrument has been absolutely proscribed by some most experienced surgeons, such as Stromeyer and Neudörfer, it certainly seems as if it were proper in injuries like these. The case is altogether different from that of operating upon an unopened skull for a suspected, but not definitely diagnosed and located, intra-cranial lesion.

Whether the trephine shall or shall not be used, cannot properly be determined by an examination of statistical tables, embracing as they must do cases of very diverse nature, operated upon under widely different circumstances. The death-rate among the English, in the Crimea, was 75 per cent. (21 out of 28), while during our war, in which the operation was resorted to seven times as often, it was but 56 per cent. (110 out of 196), 3 per cent. less than the general mortality of gunshot fractures of the skull. If penetration has occurred, shall the ball and bone-splinters be sought for? If the cranial opening is large enough to readily admit the finger, careful exploration of the track should be made; if not, and if a probe, or, which is better, an elastic searcher (for instance, a bougie) is used, the utmost care and almost no force must be exercised, lest the instrument should be pushed through the brain substance, instead of passing by its own weight along the sinus. So easy is it to do harm, that it may safely be declared that at least an inexperienced hand should never probe a penetrating head-wound. If the missile or other foreign body is felt, it should be extracted, if this can be done without special damage to the brain, the opening in the skull being enlarged if necessary. The successful removal of a bullet from within the cranial cavity, however, is a piece of surgical good fortune; and very often the ball does less damage than the search which is made for it.

Wharton's investigations would seem to prove that the search for the foreign body is less dangerous than has generally been supposed. Of his 316 cases, of which one-half (160) recovered, in 106 removal was effected with a mortality percentage of 32, while in the 210 in which there was no attempt at extraction, the corresponding percentage of death was 58. Of 111 cases of recovery in which no mental disturbances remained, in 56 the foreign body had been removed, and in 45 left; that is, in 52.8 per cent. of the whole number of the former category, and in only 21.43 per cent. of the whole number of the latter. But it should be remembered that it was probably only in the milder cases, and when the foreign body was superficially lodged, that its extraction was attempted.

TREATMENT OF CEREBRAL COMPLICATIONS.—For the relief of the meningo-encephalitis, which may be developed early, or more likely during the second week, only the ordinary anti-phlogistic treatment can be adopted, rest and cold being by far the most important elements thereof. When there is a sudden increase in the severity of the symptoms, especially the headache, or

intense cephalalgia appearing at a later period, with progressive stupor, and often rigors or convulsions, making it very probable that an intra-cranial abscess has been formed, the fractured bone should be removed, particularly if there is such paralysis present as suffices to fairly locate the pressure in the immediate vicinity of the break, and an incision should be made through the coverings and into the brain, so that, if possible, exit may be given to the pus. Though the chances of relieving the patient under such circumstances are very slight, yet, as in the case reported by Assistant Surgeon Weeds, U. S. A.,¹ recovery may follow the operation; and, if left to himself, a man thus affected is sure to die. The *hernia*, or, much more commonly, the *fungus cerebri*, which not infrequently occurs,² especially in young persons, and which, as when due to cranial and meningeal injuries not produced by gunshot violence, is so generally followed by death, is best treated by simple and moderate compression; operative interference, whether by removal, cauterization, or injection, seldom avails to prevent a fatal termination.

Of the value of the *antiseptic method* in gunshot head-wounds of all kinds, it is impossible as yet to express any positive opinion. If in the future it prove to be true that it is not the injury of the hard or soft tissues, nor the lodgment of ball or bone, that causes death—except when there occurs fatal hemorrhage, or when parts of the brain essential to life are destroyed—but pathological processes which are due to morbid agents in the air that gets access to the wound, then in the adoption of some form or other of germ-destroying or germ-excluding dressing, will lie the safety of the wounded.

GUNSHOT INJURIES OF THE FACE.

Wounds of the *face*, though frequently met with, and often causing great deformity, are comparatively seldom the cause of death,³ and then usually from hemorrhage, or from the results of maxillary fracture. Flesh wounds, if produced by single bird shot or small bullets, are rarely attended by any material destruction of tissue, are quickly recovered from, and are ordinarily followed by little or no disfigurement. When the vulnerating body is of large size (as, for instance, a charge of shot at close range, a shell fragment, or a musket ball), and when the nose, lip, eyelid, or ear, is extensively damaged, great deformity is likely to be produced, and unfortunately plastic surgery is not very often of much avail in relieving the effects either of the original loss of substance, or of the cicatricial contraction. Injury of Steno's duct may be followed by salivary fistula. In wounds of the orbital cavity, even those produced by bullets of large size, the eyeball may escape injury; but generally it is more or less damaged, perhaps destroyed outright, perhaps so contused or lacerated that destructive inflammation is soon lighted up, or that the lesion is followed by so-called "sympathetic ophthalmia" of the other eye, which is very generally not sympathetic at all, but probably due, as claimed by Lebert, to the direct transference of septic germs along the lymph spaces of the optic nerves. Immediate and total blindness of one or both eyes is at times caused by the passage of a shot from side to side through the optic nerve or nerves, no other serious damage in some of the cases being done. Penetration of the cranial cavity through the orbit

¹ Nashville Journal of Medicine and Surgery, April, 1872.

² Otis reports 61 cases, of which 50 proved fatal.

³ The mortality-rate during our war was 5.88 per cent. (462 deaths out of 7868 cases), flesh wounds proving fatal in 1.54 per cent., orbital wounds in 5.7 per cent., and fractures in 11.4 per cent. of the cases.

almost always causes death; of eighteen such wounds noticed in Wharton's table, seventeen died (94.44 per cent.). In civil life, the eyeball is not infrequently struck by a piece of exploded percussion cap that may produce simply an incised wound of the cornea or sclera, or may penetrate and lodge; and similar injury may be caused by a bird shot. In numerous cases, rifle bullets and other projectiles of considerable size have entered through small openings in the lids, or even under them, and either have lodged deep in the orbital cavity or have penetrated the base of the skull.

In a large number of these cases of gunshot wound of the face (more than one-third during our late war) *fracture* occurs, most commonly of the inferior maxilla; death results in about one-ninth of the cases, and a very considerable proportion of the remainder are followed by great deformity, suffering, paralysis, or interference with mastication. Occasionally the greater part or even the whole of the face is carried away by a large shot or a shell fragment, and very extensive destruction is often produced by suicidal shooting through the mouth, or by the discharge of a pistol held close against the chin. By the passage of a bullet through the superior maxilla, the upper dental arch may be entirely detached from the body of the bone, or, as in a case reported by Longmore as having occurred in the Crimea, the palatine process of one side may be separated and turned at right angles to its fellow.

Associated wound of the *tongue* often occurs, with or without considerable loss of substance, and at times with lodgment of a foreign body (piece of bone, tooth, ball). The primary hemorrhage in these cases may be quite profuse, and a very troublesome secondary bleeding from the lingual artery, or its dorsal or ramine branch, is of common occurrence. Local inflammation, frequently of high grade, is soon developed, and the resulting swelling may become so great as to threaten suffocation. When the anterior part of the organ has been carried away, or when its under surface has been much torn, there is danger of the tongue being so tied down by later cicatricial contraction as to be seriously interfered with in its movements. Balls, even of large size, may lodge in the *antrum* or in the *nasal fossa*, or may fix themselves in the walls of these cavities, frequently remaining there for years, at times causing no trouble, but generally producing more or less slowly progressing necrosis—a process which occasionally secures spontaneous elimination of the foreign body into the nose, mouth, or throat.

COMPLICATIONS OF FACE-WOUNDS.—Primary, and of greatly more importance, secondary *hemorrhage* from the lingual, facial, or internal maxillary artery, is a frequent complication of wounds of this region, and is the most common cause of a disastrous result: indeed, to this and to the effects of suppuration from bone-disease are due most of the deaths among these cases. Fractures of the lower jaw, with extensive loss of substance, are at times followed by *fibrous union*, with consequent impairment of function. True *ankylosis* of the temporo-maxillary articulation, and more frequently false ankylosis from the presence of cicatricial bands, may occur, and much inconvenience often follows from adhesion of the tip or side of the tongue to the lower jaw. *Paralysis*, more or less well marked, results in many cases from injury of the facial nerve, and at times *muscular twitchings*, which may persist throughout the after-life of the individual. It is in this region especially that in civil practice troublesome *powder stains* are met with, the unburnt grains lodging beneath the epidermis or the conjunctiva, or in the cornea, and producing, if not early removed, very disagreeable markings, while even if they are taken away, permanent tattooing often remains.

TREATMENT.—The *treatment* of these injuries is in general very simple, flesh wounds, unattended with much destruction, requiring only the removal of any foreign bodies which are present, and the adoption of the ordinary local measures employed in the management of gunshot wounds. The lacerated and contused soft parts are not to be removed, but readjusted as accurately as possible, and held in place, either by strips of gauze fixed by collodion, or better by sutures or pins; the abundant blood supply of the face secures the preservation of vitality, and oftentimes very speedy repair. In cases of *fracture*, no fragments that are in any degree attached are to be taken away, but are to be restored to position, and are to be held by appropriate dressings, or by frequently applied pressure of the finger, or, if about the mouth, by that of the tongue, the moulding influence of this organ often producing effects which are quite surprising. When the bones of the nose are shattered, every care should be taken to prevent or at least to lessen the sinking in of the bridge, which causes so unpleasant and suspicious a deformity. Fractures of the inferior maxilla are to be treated like similar injuries consequent upon blows, falls, etc. When there has been great destruction of the anterior part of the bone, with its overlying soft parts, every effort should be made to bring forward the edges of the tegumentary wound, and to prevent adhesion of the tongue. Unfortunately, in a large proportion of these cases, great deformity will result, but it may often be very much lessened by subsequent plastic operations. As far as possible, the secretions of the wound are to be drained away from the throat, since their being swallowed not only adds greatly to the discomfort arising from the injury, but, if they are abundant, destroys the appetite, impairs digestion, and may contribute much to the production of a fatal result.

Secondary *hemorrhage* is to be arrested by ligation of the bleeding vessel, when it can be found, or by the use of ice, hot water, the hot iron, or compression. When these measures prove insufficient, the lingual, facial, or external carotid artery, according to circumstances, should be tied. Ligation of the common carotid, though frequently resorted to, should not be adopted if it is possible to avoid it, being both dangerous and unreliable. Of 111 cases in military practice, 81 (73 per cent.), and of 16 in civil practice, 4 (25 per cent.), or, taken altogether, 85 out of 127 (67 per cent.) cases have terminated fatally, while death has also followed in three out of seven cases of ligation of the external carotid alone, or 42.85 per cent. (Wyeth). Of the 54 cases of ligation of the common trunk which occurred during our late war, in at least 14 (26 per cent.) there was subsequent hemorrhage; and of the remaining 40 cases, 14 ended fatally in the first week, and 11 of these within the first four days; so that it is fair to infer that had the patients lived a little longer, there would have been a decided increase in the number of secondary bleedings.

Wounds of the *eye* and its appendages are to be treated like those produced by other causes; if lodgment of the foreign body has taken place, and vision has been destroyed, the eyeball should be removed at once, to prevent the development of sympathetic ophthalmia. If a considerable part of the *ear* has been carried away, little or nothing can be done to correct the resulting deformity; but this is a matter of comparatively small importance, since the hearing is not affected, and the disfigurement can generally be readily concealed. If the bullet has lodged in the external auditory canal, it should be removed, even if it be found necessary to displace forwards the auricle and cartilaginous meatus in order to do so.¹ *Powder grains* are to be carefully

¹ Green, of Boston, has recently reported a case in which by making "a semicircular incision above and behind the auricle, through the periosteum," carrying forward "the periosteum with the auricle till the edge of the osseous meatus was reached," and cutting through "the insertion of the cartilaginous into the osseous passage in its upper and posterior part," he was able to discover and remove three pieces of two small pistol balls which had been fired directly into the ear.

picked out, or, if they are so placed as to render it practicable, a blister may be applied, upon the drawing of which the grains will be found either detached or so loosened as to be readily removed.

GUNSHOT INJURIES OF THE NECK.

Wounds of this region are, as a rule, of importance only when involving the air-passages, the pharynx or œsophagus, the great vessels, or the larger nerves. Mere contusions from spent balls or shell fragments may cause temporary paralysis of the muscles of the neck, or of the upper extremity, or even muscular rupture with resulting distortion, and may be followed by more or less sloughing. Superficial wounds, that is, those not passing through the deep fascia, usually heal in due time—often very quickly when produced by small pistol balls or bird shot—though occasionally the cure is much delayed by the supervention of erysipelas, or of suppurative inflammation of the subcutaneous connective tissue. Of the deeper wounds, those of the lower part of the neck are more dangerous than those of the upper, death in many cases of the former category being consequent upon the extension of inflammation along the fascial planes to the parts within the thoracic cavity. When the injury is confined to the posterior part, but comparatively little damage is usually done, unless the vertebræ are wounded, although temporary paralysis, even to the extent of involving all four extremities, may result from spinal concussion, and more lasting paralysis and muscle-atrophy from lesion of the nerves soon after their emergence from the vertebral canal. Injuries of the *muscles* are ordinarily recovered from without difficulty, and with no serious after-results other than, at times, deformity consequent upon cicatricial adhesions, when the superficial tissues have been extensively destroyed, and upon contractures from loss of substance in the muscles themselves. Torticollis, which chiefly follows wounds of the sterno-mastoid, may be permanent, or, as is more usually the case, may ultimately disappear, either wholly or in great measure.

The exposed position of the *larynx* and *trachea* renders them quite liable to injury, though actual penetration is in a limited number of cases prevented by their deflection of musket bullets and much more frequently of small balls and shot. Small shot may even pierce the cartilaginous wall and lodge under or in the mucous membrane, laryngitis or tracheitis being in consequence developed.

I once examined, after death, a case of this sort, in which a charge of bird shot at short range “peppered” the upper part of the left chest and the front of the neck, making an extensive laceration just above the right sterno-clavicular articulation. The fatal result was due to laryngitis consequent upon the lodgment of a single shot under the mucous membrane covering the left wing of the thyroid cartilage.

Very rarely does the missile enter the air-tube without passing through, though such cases have been observed, the vulnerating body producing results similar to those which follow the introduction of any solid substance through the glottis. Suffocation, actual or impending, may be produced by the pressure of inflammatory products external to the trachea. Cicatricial contraction after extensive destruction of the anterior part of the larynx, or inflammatory stenosis, may compel the permanent wearing of a tracheal tube. Aphonia, in greater or less degree, very frequently follows injuries of this sort; necrosis of the cartilages is quite likely to occur; and aërial fistulæ at times remain.

A missile passing high up may wound the *pharynx*, or, at a lower point, the *œsophagus*; only very rarely is there associated lesion of both the air-

and food-tubes. The existence of an opening into the pharynx or œsophagus may be proved by the ready escape, through the external wound, of liquids or semi-solids taken into the mouth; in many cases the presence of such an injury is but conjectural, from the line of direction of the shot; and occasionally it is revealed only by an autopsy. Persistent fistulæ are not unlikely to follow such lesions. Outflow of alimentary substances through a laryngeal or tracheal wound does not necessarily indicate opening of the pharynx or œsophagus, as it is at times due to impaired functional integrity of the epiglottis, permitting the entrance of food or drink from above into the air-passage.

Much the most dangerous of the neck wounds are those involving the *great vessels*, many of these causing speedy death from primary hemorrhage. Oftentimes even the large arteries and veins escape injury in a remarkable manner, and, when wounded, bleeding is occasionally prevented temporarily by the bullet lodging against the opening and plugging it; or, after the first gush, the discharge of blood may be, though very seldom, permanently arrested by the presence of a clot. *Traumatic aneurism* is not infrequently developed, and *arterio-venous aneurisms* have also been observed in these cases. Extensive *extravasations* of blood may take place, at times causing serious or even fatal pressure upon the air-tube; and considerable quantities of blood have been found poured out within the carotid sheaths. Medium-sized bullets may lodge in the carotid artery or in the internal jugular vein, or may become encysted upon the vessel's wall, or, after entering, may drop down and be arrested at a lower level. Wounds of the *nerve trunks*, unaccompanied by grave injuries of the bloodvessels, of the spine, of the head, or of the chest, cause the ordinary disturbances of motion and sensation in the parts supplied, and by reflex action, in certain rare cases, in regions quite remote. Lesion of the hypoglossal nerve has been followed by motor paralysis and unilateral atrophy of the tongue;¹ that of the sympathetic, by contracted pupils, ptosis, and flushing of one side of the face;² to injury of the pneumogastric, was attributed by Larrey the intense thirst which is at times experienced by the subjects of œsophageal wounds; injury of the brachial plexus, whether produced by ball or bone fragment, very often causes not only the usual muscular affections in the upper extremity, but trophic changes in the skin, and that burning pain (*causalgia*) which is "the most terrible of all the tortures which a nerve wound may inflict." (Mitchell.) Mere pressure of a lodged ball may give rise to severe nervous symptoms, which disappear with the removal of the foreign body.

Of this an instance is reported by Sawtelle, in which pain, clonic contractions, and sensitiveness to heat and cold, were through nearly seven years produced by a conoidal ball that entered "about half an inch above the left clavicle and about one inch from its sternal extremity, passed transversely between the trachea and the œsophagus," and lodged on the right side "between the subclavian and a branch of the brachial plexus, the ball resting on the artery just where it emerges from beneath the clavicle, with the nerve drawn tightly across the missile in front." Removal of the bullet was followed by rapid healing and progressive relief of suffering, so that in two and a half years the recovery was declared to be entire, "with the exception of a very slight sensitiveness of the fingers to cold and heat."

Occasionally several of the important nerves are simultaneously injured, as in a case reported by Stromeyer, in which the phrenic, the pneumogastric, the middle ganglion of the sympathetic, and the descendens noni, were wounded together with the larynx and pharynx. It sometimes happens that a deeply penetrating shot, although it may not directly damage important structures,

¹ Mitchell, *Injuries of Nerves*, pp. 218, 335. Philadelphia, 1872.

² *Ibid.*, p. 318.

may cause a burrowing abscess which by subsequent ulceration of a large vessel, or by descent into the chest, will bring about a fatal result.

In a case of this sort reported by Surgeon O. A. Judson, U. S. V., the abscess cavity "reached upward five or six inches along the spine, and downward in the mediastinum to the bifurcation of the trachea, where the ball was found, point downward and resting against the right bronchial tube."

PROGNOSIS.—Leaving out of consideration such as necessarily and quickly prove fatal from hemorrhage, or from associated injury of the brain or spinal cord, neck wounds cause death in a much smaller proportion of cases than might naturally be expected from the number and importance of the structures contained in this region.¹ At least one-half of the wounds of the air- and food-tubes that come under treatment terminate fatally, and in a large proportion of those made by musket balls, there are associated lesions of more important parts that speedily cause death. As a rule, when one of the great bloodvessels is opened by a shot, life is quickly destroyed by the primary hemorrhage; but the bleeding may be arrested by compression (as in the well known case of the Duke of Padua, reported by Larrey), by the presence of the ball, or by the formation of a clot, and an opportunity may thus be afforded for the application of a ligature or of methodical pressure. According to S. W. Gross, wounds of the internal jugular vein have always resulted fatally, but in two of the cases which he cites (Schwartz's and Stromeyer's), the rent in the vein was completely healed at the time of death from pyæmia. Contusions of the main vessels are very likely to be followed by secondary hemorrhage, the detachment of the slough generally taking place at about the end of the second week, though sometimes much later; in a case of injury of the common carotid, observed by Cruz, of Lisbon, the bleeding "did not show itself until the thirty-seventh day." The prognosis in cases of nerve-wound unaccompanied by other grave lesions, is favorable as respects life, but not so as regards the after-comfort of the patient and the usefulness of the parts supplied by the damaged nerves.

TREATMENT.—In the treatment of all varieties of neck-wounds in which the missile has lodged, unless this is quite small, it should be removed, provided that its location can be determined, and that it can be reached (if necessary) by a careful dissection which will not in itself seriously imperil life. Though balls may remain for years without causing inconvenience, yet in the great majority of cases their presence does harm, and not infrequently develops severe and often fatal inflammation. Even after such inflammation has been lighted up, it may quickly subside upon the removal of a foreign body, the lodgment of which, though it is perhaps of large size, may not have been at first suspected.

In a case reported by Duplay, a mitrailleuse ball, more than an inch and a half in diameter and of over six ounces weight, was for nearly four months lodged undiscovered between the lower jaw and the hyoid bone. Upon its removal, rapid healing took place.

Injuries of the *larynx*, *trachea*, *pharynx*, or *œsophagus*, are to be treated in the ordinary way. Threatened suffocation, if due to pressure of extravasated blood, or superficially located effusions and exudations, is to be relieved by free incision and by removal of the clot, if such be present, or by tracheotomy; if to œdema of the glottis, by scarification, or by the opening of

¹ In only 15 per cent. of the nearly five thousand (4895) cases tabulated by Otis, and even this is declared to be an excessive ratio because of the inclusion of many cases of grave injury that never came under treatment.

the air tube; and by the latter operation, if consequent upon inflammatory stenosis located sufficiently high to permit of the incision being made below the point of obstruction, or by the introduction of a tube through the original wound. Tracheotomy, in all these cases, is quite likely to be followed by a fatal result, not because of the operation itself, but because of the conditions by which it is rendered necessary. It was resorted to six times during our late war—twice successfully. In cases of lesion of one of the large *bloodvessels*, the resulting hemorrhage, whether primary or secondary, should be arrested by the application of ligatures above and below the wound, if such can be safely found; otherwise, by compression. When it is an important branch of the external carotid that has been damaged, if it cannot be duly tied on either side of the wound, the ligature should be placed upon the external carotid itself, and not upon the common carotid. The ligature of the latter trunk is, as we have already seen, though easier of execution, much more dangerous and more likely to be followed by after-bleeding, and the operation should not be resorted to except for wound of this vessel itself. The internal jugular vein, when wounded, should be tied rather than compressed, though by methodical pressure hemorrhage from this vein has often been arrested. As has been before noticed, Langenbeck has advised in these cases that either both the common carotid and internal jugular, or, preferably, the common carotid alone, should be ligatured. Two objections have been strongly urged against tying the vein: (1) that phlebitis was likely to be developed, and (2) that cerebral damage would ensue from the resulting interference with the return circulation. The first objection is now known to have but little weight; and as respects the second, though cases have been reported of early occurring apoplexy after ligature of this vessel, yet by many experiments, as recently by those of Nicaise, it has been clearly shown that an ample collateral venous circulation may be expected to be rapidly established after ligation of the internal jugular vein, as also after that of the subclavian.

GUNSHOT INJURIES OF THE CHEST.

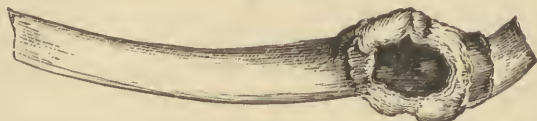
About one in twelve (at least one in twenty) of all gunshot wounds are of this region, and here, as in the head, the injury may affect the soft parts only, or the bony wall, or the contents of the cavity; and the gravity, aside from the comparatively few not immediately fatal cases in which the large vessels are damaged, is directly proportionate to the extent of visceral lesion.

NON-PENETRATING WOUNDS.—Superficial wounds, even if of large size, *unattended by fracture*, rarely cause death—in perhaps only one out of every two hundred cases—though, owing to the constant movement of the chest, healing usually takes place very slowly. Very long seton tracks are not seldom met with, the ball running around over the ribs; and on this account, an erroneous diagnosis of perforation is oftentimes made. Occasionally, and then almost always as the result of contusion by a shell-fragment, there is an associated serious lesion of the lung, laceration or rupture—a lesion which probably can only occur when the glottis happens to be firmly closed at the moment of injury. Such an accident generally, though not inevitably, proves quickly fatal; 25 cases collected by Otis gave 11 recoveries.

When any part of the bony wall is *fractured*, the wound becomes one of much greater importance, not only on account of the fracture itself, but, in higher degree, because of any accompanying injury of the subclavian or axillary vessels, when the clavicle or scapula is wounded, and of the intra-thoracic viscera, the pleura, or the intercostal or internal mammary arteries,

when it is a rib or the sternum that has been struck. Circumscribed pleurisy is a frequent but not necessary consequence of costal fracture, and extensive necrosis may follow the bone-injury. When the fracture is produced by an out-going shot, it is (as was originally pointed out by Brinton) decidedly less

Fig. 292.



Gunshot fracture of rib by round musket-ball which was embedded. (A. M. M., Sect. 1, Spec. 887.)

dangerous than under other circumstances, all splinters being then carried away from the cavity, and bone-fragments being more likely to do harm to the lung than the bullet itself. Small balls at times bury themselves in the ribs, or in the sternum, and a bullet of even large size may wedge itself firmly in an intercostal space, ultimately, if not removed, working its way externally, or by ulceration and absorption getting into the pleural sac. When a costal cartilage is struck by other than a small missile, fracture takes place, but without a scattering of fragments.

The treatment of non-penetrating chest injuries, whether there is or is not fracture present, is that of like wounds in general, in no way materially modified because of location. *Foreign bodies* are to be removed, if they can be found; but their discovery is at times very difficult, as when the projectile, even if of large size, is lodged under the scapula, or buried deep in the muscles of the back, or in or near the axillary space. *Hemorrhage* is to be arrested, preferably by ligation of the wounded vessel above and below the point from which it bleeds, or, if this cannot be done, by compression, or by the use of cold, or of hot water. The exceedingly dangerous bleedings from the axillary vessels (those from the artery being much graver than those from the vein) which often cause rapidly forming, diffused, traumatic aneurisms and blood-tumors, though undoubtedly they have at times been stopped by compression, yet can be safely treated only by ligation, at the seat of injury rather than above it, or by ligation followed by amputation of the whole upper extremity. Wound of an intercostal artery, though fortunately not very common, may, when it does occur, especially if located far back, give rise to a very considerable hemorrhage, which is to be treated by direct compression rather than by ligation, an operation which is here neither easy nor safe; of eight cases in which it was attempted during our civil war, six proved fatal. Formal *excision* of fractured bones should not be employed, except at a late period, for extensive necrosis; though the sharp ends of a broken clavicle or rib may often with advantage be cut off. As in simple fracture, compression of the chest or half chest with a broad bandage, with adhesive straps, or with a plaster-of-Paris roller, will afford much comfort and hasten recovery.

PENETRATING WOUNDS.—It is to penetrating injuries that the special interest of thoracic wounds attaches. Though they may vary greatly in the amount of damage done, and in the complications developed, they are always grave lesions. In military surgery, many of the subjects of these injuries are left on the field, and in civil practice speedy death is not infrequent. For their production, it is not absolutely necessary that the projectile should enter the thoracic cavity, as the pleura, alone or together with the lung, may be wounded by bone-fragments. At times, chiefly when the vulnerating body is a pistol-ball or a small shot, laceration of the pleura or even penetration

of the lung may occur without associated fracture, the missile entering through an intercostal space. Still more rarely, in an apparently external seton wound, the ball may cut the serous membrane for a considerable distance in its passage between two ribs. In the non-fatal cases of entrance, with or without lodgment, it is usually the outer surface, or the thin edge, of the lung that is wounded, though exceptionally the shot may pass through the thickness of the organ, or may even be buried close to its root. This last form of injury is generally followed by death from hemorrhage; almost certainly so unless the missile be of small size. Occasionally a bullet, after wounding the pleura, runs over the lung for a variable distance, to be either deflected internally, or to emerge through a rib or an intercostal space. Very rarely, if ever, does a rifle-ball pass from side to side through both lungs, and the patient recover.

A *lodged bullet*, if the wounded individual lives, is very apt to become encapsulated, though at times it may be found in an abscess cavity, or may enter a bronchial tube, and be coughed up; or the œsophagus, and pass downwards, or be ejected through the mouth; or, if superficially placed, it may so work its way externally as to make it practicable for it to be readily removed; or, adhesions not preventing, it may drop down in the pleural sac, where it may either remain free, rolling about upon the diaphragm, or, which is more probable, may rest in the postero-internal angle. A spiculum of bone is more likely to cause the formation of an abscess, and may in this way, or by ulceration, find entrance into a bronchial tube; though it may, especially if small, remain innocuous in the lung tissue either with or without capsular investment. Penetration may occur without lung wound, the missile damaging the pericardium or heart, or lodging in the mediastinum, or even passing directly through without injuring any important structure.

In a remarkable case reported by E. S. Cooper, in which, however, the lung was injured, an iron breech-pin was lodged "beneath the heart, upon the vertebral column, just to the right of the descending aorta," from which place it was successfully removed seventy-four days later.

During the Ashantee war, in 1873, there died of dysentery an English naval officer who, in 1860, in New Zealand, had been wounded in the right breast, the resulting symptoms being so slight as to make it very doubtful if penetration had occurred. Upon *post-mortem* examination, there were found a cicatrix above the right nipple; evidences of damage to the fourth rib near its cartilaginous junction; and an encysted round ball, about half an inch in diameter, lying "outside the pericardium, above the right ventricle, in the triangular interspace between the aorta and the pulmonary artery."

Hernia of the lung is very rare, and, when it does occur, is almost always a primary complication, though it may appear at a later period in consequence of the feeble resistance offered by a cicatrix. When the missile passes through the seventh, eighth, or ninth intercostal space, especially the latter, and when the diaphragm is wounded, particularly on the left side, *omental hernia*, or even visceral protrusion, may result. If the diaphragm is strongly arched at the time of injury, it may be wounded in two places, and herniæ may occur through both. When the protrusion is recent, and the presence or absence of crepitation in the tumor can be readily and certainly determined, it is easy to distinguish between a pneumocele and an epiplocele, but at a later period, after inflammation and strangulation have occurred, a differential diagnosis cannot usually be made. As the result of the injury of the lung, circumscribed inflammation may be expected to occur along the track of the ball; but ordinary *pneumonia* is rarely developed—never as the direct consequence of the traumatism alone. The inflammation of the *pleura* may be limited and protective (and in this sense only is it true, as declared by Mouat, that "the inevitable result of a wound of the lung is pleurisy"), or, as is often the case, may

be general and purulent, because of the escape of blood, and its admixture with air from the exterior, or from the opened air vesicles or bronchial tubes. When the entrance wound is large, or the pleural effusion abundant, compression of the lung takes place—to be subsequently, in cases that recover, more or less relieved by absorption or discharge.

Lesions of the *pericardium* or *heart*, if not quickly fatal, give rise to pericarditis and endocarditis of varying extent and duration, and a lodged shot may become encapsulated. *Mediastinal wounds* may cause suppurative or gangrenous cellulitis.

Diagnosis of Penetrating Wounds.—The diagnosis of penetration, aside from cases in which an external opening is associated with profuse hæmoptysis, is often by no means easy, and is to be based upon an aggregation of symptoms rather than upon any one symptom by itself. *Spitting of blood* may be present when the lesion does not directly affect the lung. *Shock*, perhaps in high degree, may show itself when the lung is undamaged, and is often absent even when a fatal penetrating wound has been received. Severe *bleeding* may arise from an intercostal or the internal mammary artery, and *hæmothorax* is not uncommon after a lesion of the former. In *pneumothorax*, the air may come from without, and in the very rare cases of *emphysema* which follow a bullet wound, the effused air may have been sucked in from the surrounding atmosphere, and not forced out of lacerated air-vesicles or tubes. *Traumatopnœa*, while it shows that there is an opening of the pleural cavity, does not prove that the lung has been torn. *Dyspnœa* from pleural accumulations of blood, air, or pus, cannot be regarded as pathognomonic, since each of these exciting causes may exist independently of lung wound. The late-occurring *lumbar ecchymosis* of Valentin is very often absent, and is of no special importance in the cases in which it does occur, having really little or no diagnostic value. From the presence of *two wounds*, perforation cannot be predicated, since the ball may have run around the body, or the patient may have been struck by two shots. Early and persistent, marked *reduction of temperature* furnishes strong presumptive evidence of visceral lesion. Injury of the *heart* or *pericardium* is rendered probable by quickly appearing, great shock and precordial oppression, with succeeding pericarditis or endocarditis.

Prognosis.—The prognosis of these penetrating wounds is very grave. Among the Russian wounded in Sympheropol 98.5 per cent. of those who were thus injured died, as did 91.6 per cent. among the French and 79.26 per cent. among the English in the Crimea. Of 7929 cases observed during our war 5169 (65.19 per cent.) ended fatally, and if the non-fatal cases in which errors of diagnosis were made could be eliminated, the mortality rate would unquestionably be carried decidedly higher. In civil life—the missiles, as a rule, being smaller, the cases coming under treatment earlier, and the patients not being subjected to added dangers from transportation—the prognosis is more favorable, but still bad enough. Even in cases which do not terminate fatally, in both military and civil practice, long-continuing or permanent fistulæ may remain. *Heart wounds*, when made by large balls, almost always prove quickly fatal; when made by small bullets or shot, life may be prolonged for a considerable period of time, and recovery even may take place.

In a case which I have elsewhere reported, and which was under my own observation from the time of injury to that of death, three years and two months later, a small pistol-ball, as was proved by an autopsy, passed through three of the four cavities of the heart, and lodged in the root of the right lung—the boy, aged 15, ultimately dying of the effects of the cardiac disease.

Pericardial injuries are much less dangerous than heart wounds: four out of the seven cases in Fischer's table ended in recovery.

Treatment.—The treatment of penetrating wounds of the chest depends upon the *size* of the vulnerating body; upon whether *lodgment* within the cavity has or has not taken place; and upon the *complications* that may be early or late developed.

When the missile is small—and such it is likely to be in that large proportion of cases treated in civil practice in which the injury is produced by a pistol ball—if the shot has passed through and can be felt lodged under the skin, it should be removed, but should otherwise not be searched for. In wounds by large bullets, or by a fowling-piece charge at short range, the track of the wound should be explored by the finger, and any foreign bodies that are discovered (lead, buttons, clothing, bone fragments), removed. If, as is likely to be the case, the ball has passed beyond the point which can be reached by the finger, shall any probing be done? Not with a metallic instrument. An elastic bougie, or a gum catheter, may very properly be used, if guided by intelligence and judgment; since if the lodged substance can be found and removed, either through the wound or through a counter-opening, the patient's mind will be put much at ease, and the after local mischief will probably be much less. But the chances of finding the ball, except when it is very superficially located, are not great—much less than the possibilities of doing harm; so that here, as in head injuries, it is, as a rule, safer and wiser for all except the most experienced to rest content with the knowledge acquired by digital exploration, that penetration has *probably* taken place, and to let the foreign body remain, trusting that it will either become encysted or be spontaneously expelled through the air passages or the œsophagus, or that it will be brought near to the surface by suppuration so as to be easily removed when the abscess is opened, or extracted through a sinus. If at any time during the progress of the case, the bullet can be discovered free at the bottom of the pleural sac, it should be taken out, either through an existing opening or through one specially made in the posterior part of one of the lower intercostal spaces.

Hemorrhage from an intercostal artery is to be arrested, as already stated, by plugging; and if from the *internal mammary*, by ligation—direct, if possible; if not, higher up, in the second, third, or fourth intercostal space. This operation was twice employed during our war, though unsuccessfully; but pressure and styptics were equally unavailing in saving life in the four cases in which they were tried. The bleeding from this vessel then when it does occur, which is not often, is to be regarded as a very serious matter. When the hemorrhage, though from neither of the above-mentioned arteries, is yet profuse, it should if possible be checked by rest, by the application of cold, and by the administration of ergot—preferably hypodermically; the patient meanwhile should be placed in such a position that the blood will flow off through the wound. Pressure upon, and closure of, the external opening will often be found of great service, but “hermetically sealing,” after the method of Howard, has proved to be far from advantageous. Effusion of blood into the pleural sac, whether from an internal or an external source, if of limited amount, is usually absorbed without difficulty, with relief of the primary symptoms, shock, pain, and dyspnea. When the extravasation is large, death may take place quickly from the hemorrhage and lung compression, or more slowly from empyema, or, the bleeding having been arrested by the pressure of the clot, absorption may follow, the lung may expand, and the patient may recover. In all of these cases, absolute rest must be enjoined, and cold, opium, and ergot should be employed according to circumstances. The external opening may be closed in order that by compression further

bleeding may be prevented, but if the dyspnœa becomes extreme, the wound must be reopened and the blood allowed to escape. If the outflow is not sufficiently abundant, aspiration or paracentesis may be practised; or a free incision may be made in an intercostal space, and, if necessary, the pleural sac may be thoroughly washed out; such an opening of the cavity can do little or no harm, air having already gained access from the first along the track of the bullet.

The old time treatment of chest wounds by *venesection* is not to be adopted, since it will almost certainly but add to already dangerous conditions, that of "irrecoverable exhaustion." *Pneumothorax*, if producing severe dyspnœa, which is not of common occurrence, should be relieved by tapping. *Purulent accumulations*, whether due to decomposition of blood from the entrance of air either from without or from the wounded lung, or to general pleuritis, may at times be removed by aspiration or by tapping, but are, as a rule, best treated by free incision with or without removal of part of a rib or ribs, and by subsequent cleansing of the cavity and maintenance of drainage, which should be as thorough as possible. Very generally, however, though temporary relief is thus afforded, cases of gunshot empyema sooner or later terminate fatally.

That recovery may take place in cases of great severity, is well illustrated by a case reported by Schneider of Königsberg, in which after a pistol-ball wound of the chest smashing the fourth rib, *pyo-pneumo-hæmothorax* occurred, together with sloughing of the upper lobe of the lung. In order that the ribs might close in upon the unfilled cavity, resection was practised—part of the clavicle and pieces of the second, third, fifth, and sixth ribs, of from two to four and a half inches in length, from the costochondral junction outwardly, being removed. The resection wounds healed by first intention, the chest wall collapsed, and the man recovered.

The ordinary, limited, *pleural* and *pulmonary inflammation* along the track of the wound requires no special treatment. The lung injury may be so perfectly recovered from that auscultation will fail to indicate that any damage has been done, but usually the physical signs of the existence of condensed cicatricial tissue will ever after be present. Tubercular disease has ultimately been developed in a considerable proportion of the patients who have apparently completely recovered from lung wounds; but in what degree this disease has been really consequent upon the injury, it is impossible to determine.

A quickly appearing *hernia of the lung*, if seen before any inflammation or strangulation has taken place, should, if the protruding portion is unwounded, be, if possible, at once reduced, the opening in the chest wall being enlarged if necessary, and a retentive dressing being afterwards applied; at least once (Angelo's case), such a reduction has been successfully effected. When injured or already inflamed, the protrusion should be left undisturbed. If there has been a wound of the diaphragm, and a portion of the contents of the abdominal cavity protrudes, similar treatment should be adopted. Injuries of the *pericardium* and *heart*, which do not quickly cause death, should be treated at first by rest, cold, and closure of the external wound, the latter being subsequently reopened if symptoms of dangerous compression are manifested; in the beginning, however, every effort is to be directed towards preventing or arresting hemorrhage, and favoring speedy cicatrization of the internal wounds. The same principles should govern the surgeon in the treatment of *mediastinal wounds* attended with much bleeding, but without associated heart lesion. Stimulation if resorted to at all, must be so with great care and judgment. At a later period, if pericarditis and endocarditis are developed—and, while frequent, such inflammations are not necessary consequences of the injury—they are to be treated in the usual way.

GUNSHOT INJURIES OF THE ABDOMEN.

As the result of gunshot injury, there may be produced in this region (1) contusion; (2) parietal wound; and (3) penetration of the cavity, with or without visceral lesion—the missile either lodging in the abdomen, or perforating the cavity to emerge through a second external orifice, or to be arrested at some point beneath the unbroken integument. There may be associated wound of the chest wall or thoracic cavity above, or of the pelvic cavity below, or of the spine behind.

CONTUSION may result from the blow of a nearly-spent cannon-shot or shell fragment, or from a grazing bullet, or from the more direct impact of a musket or pistol ball, the momentum of which is insufficient to overcome the elasticity of the skin. When the missile is large, there may be produced only tearing of the superficial vessels, with resulting extravasation in greater or less amount; or rupture of muscles; or laceration of the abdominal viscera, especially of the liver or of an enlarged spleen; or even lesion of the great bloodvessels.

PARIETAL WOUNDS.—When there is a *parietal wound*, the bullet may lodge at no great distance, or may cut across the wall, or may form a longer or shorter seton track, or being deflected may run around, to emerge or to rest at a point nearly or quite opposite the place of entrance—a round ball, at times, even completely girdling the abdomen. Large vessels may be injured, or the peritoneum bruised, or, though rarely, the kidney or an uncovered portion of the intestine damaged. It is even possible that a pre-existing hernia may be wounded, as in a case reported by Medical Inspector Gihon, U. S. N. In both contusions and non-penetrating wounds, especially when there has been extensive extravasation, parietal abscess frequently results.

PENETRATING WOUNDS.—When the serous membrane is pierced, the ball may glide over the contained viscera without wounding them. On theoretical grounds the possibility of such an occurrence has been denied, but the fact that it does take place has been amply established by post-mortem examination.¹ (See Fig. 313, page 204.)

Ordinarily, in penetrating wounds of the abdomen resulting from gunshot injury, lesions of the hollow or solid viscera, or both, are produced, and multiple wounds of the intestinal coils are frequent.² Protrusions of healthy or damaged omentum, or of bowel, may quickly occur, though bullet wounds are not likely to be followed by such complications. Injured portions of even the solid viscera (liver, kidney, rarely the spleen), may appear externally. As the result of early fixation of the damaged intestine, an *artificial anus* may ultimately be established, either with, or, as is much more usually the case,

Fig. 293.



Loops of ileum with shot-perforations. (A. M. M., Spec. 1231, a.)

¹ In his address before the surgical section of the American Medical Association, at Richmond, Va., in 1881, Dr. Hunter McGuire reported four such cases that had come under his own observation.

² Longmore reports a Crimean case in which, upon autopsy, it was found that "sixteen openings had been made in the small intestines by the bullet," which "entered near the umbilicus and passed out close to the scrotum," the man having been hit "while stooping in the act of defecation." In the case of the late J. Fiske, Jr., there were "four perforations of the small intestine, two of the large, and fourteen perforations or distinct wounds of the peritoneum." (Peugnet.)

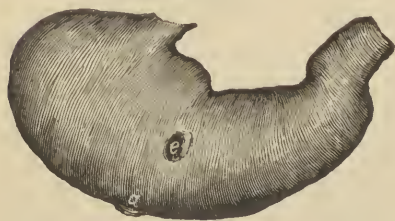
without a projecting *éperon* or spur. A hernia may be found at the opening made for the extraction of the lodged ball. When the diaphragm has been perforated, the protrusion may be into the thoracic cavity, or, as we have already seen, it may show itself through an external chest wound. The bullet may primarily enter and lodge in the stomach or bowel, to be soon discharged *per anum* (in fourteen hours in one of Lidell's cases), or may subsequently, by ulceration and absorption, work its way through the intestinal wall, generally that of the colon, and after a number of days be voided at stool. Encapsulation may take place even in one of the solid viscera.

DIAGNOSIS OF ABDOMINAL WOUNDS.—Though the likelihood of penetration having occurred is much greater here than in a wound of the head or chest, the diagnosis cannot certainly be made by the apparent line of direction of the shot, nor even by the resulting shock or the functional visceral disturbances. As has already been mentioned, there may have been deflection of the bullet, and thus only a parietal injury may have been inflicted.

Shock, though of more probable occurrence in lesions of the peritoneal, than in those of any other cavity, may be noticed in high degree when only a comparatively superficial abdominal wound has been received, and is, on the other hand, at times absent when a fatal visceral perforation has taken place. The results of *hemorrhage* from one of the larger secondary parietal vessels may be mistaken for it. Vomiting of blood, or hemorrhagic discharges from the intestinal canal, may be consequent upon a simple and soon-recovered-from contusion, and a similar injury along the course of the urinary track may be followed by the appearance of blood in the urine; though if the hemorrhage in any of these cases is in large amount, the probability of visceral wound is very strong. When the diaphragm has been involved in the injury, and hernia has taken place through it, there will generally be little or no contraction of that muscle on the wounded side. If, in a case of contusion, *meteorism* quickly follows, that symptom very strongly indicates rupture of the bowel. Early and persistent, *subnormal temperature* renders it very probable that there has been grave organic lesion. The only positive evidences of penetration, however, are furnished by the outflow of the contents of the stomach or bowels, of bile, or of urine; by protrusion; or by seeing or feeling the parts within the peritoneum.

PROGNOSIS.—The prognosis in the *non-penetrating injuries* met with in time of war, while of more gravity than in like wounds of the head and chest, is

Fig. 294.



Gunshot perforation of stomach; a, wound of entrance; e, wound of exit. (A. M. M., Spec. 3749.)

yet favorable,¹ though death may result from peritonitis, or, rarely, from hemorrhage or other wound complication. In civil life, in which, because of the ordinarily less size and velocity of the missile, peritoneal or bowel injury is very much less likely to be produced, the mortality is much smaller; so much so that, speaking generally, it may be said that, under these circumstances, recovery is almost certain to take place.

Penetrating wounds, on the other hand, are most dangerous, 87.72 per cent. of those occurring in our late war having proved fatal (3008 out of 3429 determined cases), as did 91.7 per cent. (111 out of 121) of the French, and 92.5 per cent. (111 of 120) of the English cases in the Crimea. When involv-

¹ Otis reports a mortality-rate of 8.07 per cent.: 253 deaths out of 3134 determined cases.

ing the *stomach* or *small intestine*, these wounds may always be expected to cause death, generally from peritonitis following extravasation, or from very acute septicæmia. Otis declares that "the unequivocal recoveries from shot wounds of the stomach, with or without fistula, number only six or seven"—fistula having occurred but twice, in the case of Alexis St. Martin, and in that reported by Baron Percy; and the same authority doubts if during our war there was a single "incontestable instance of recovery" from wound of the small intestine, though in five cases that got well there was more or less "plausible ground for suspecting" that the lesion was of such a nature. The

Fig. 295.



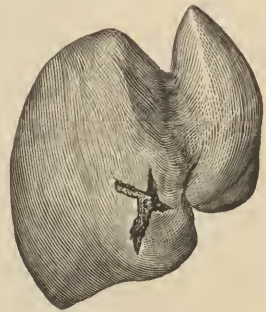
Jejunum perforated by a pistol ball, showing eversion of mucous membrane. (A. M. M., Spec. 841.)

records of military surgery certainly furnish but very few cases of recovery from gunshot perforation of this part of the bowel. If the wound has been made by a small pistol ball, as it is likely to be in cases occurring in civil life, the opening may be so small that escape of fluids may at first be prevented by an eversion of the mucous membrane of the gut, aided by the temporary paralysis of the damaged part of the tube, which is produced by the blow, and thus time may be afforded for the formation of adhesions that shall protect the general peritoneal cavity.

The prognosis in injuries of the *large intestine* is much more favorable, particularly when it is the ascending or descending part of the colon that has been wounded. In at least 20 per cent. of the cases of this nature tabulated by Otis, recovery took place, stercoral fistula having been formed in a large proportion, but having, in most instances, become spontaneously closed in the course of a few months. In many of these non-fatal cases, the wound, it is probable, was in an uncovered part of the bowel, so that in reality the peritoneal cavity was not opened; and it is in this opening of the peritoneum, with the resulting inflammation, or, much more rarely, large hemorrhages, that lies the excessive danger of intestinal wounds.

When the *liver* has unquestionably been wounded, as proved by the escape of bile, or by the protrusion of a part of the organ, though death is very apt to occur, from hemorrhage, from hepatic abscess, or from peritonitis, yet recovery may take place. In at least 14 of the 59 uncomplicated cases analyzed by Otis (23.7 per cent.), and in 18 of the 111 cases in which there were associated lesions of other important parts, and of which the terminations were ascertained (16.2 per cent.), the patients did not die; and it is quite possible that in a number of the thirty other cases of recovery from supposed liver wounds, the organ was really damaged. Even when the *gall-bladder* has been injured, a fatal result is not inevitable,¹ though almost certain to occur from extravasation

Fig. 296.



Section of liver showing gunshot perforation of right lobe. (A. M. M., Spec. 1232.)

¹ In at least one case, that of Paroisse, a bullet has been found in the cavity of the gall-bladder, death having occurred long after the receipt of the injury, and from a totally independent cause.

and consequent peritonitis. The much more rarely observed wounds of the *spleen* are at times recovered from, but are usually followed by mortal hemorrhage. As in the case of the liver, protrusion of a part of the viscus does not necessarily prevent a favorable termination. Though it is true that the existence of a wound of the *pancreas* can generally be ascertained only upon autopsy, and though such a lesion must usually be associated with other very serious if not mortal injuries, yet, if hernia should take place, it need not necessarily add materially to the gravity of the prognosis, since the protruding part of the pancreas may be successfully removed, as was once done during our late war.

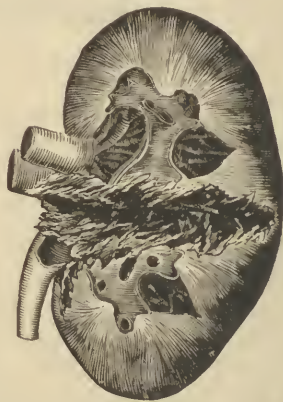
Kidney lesions, which are often associated with injury of the spine, or of some other of the solid or hollow viscera, though rarely followed by intra-

Fig. 297.



Pancreas with conoidal musket ball embedded.
(A. M. M., Spec. 2884.)

Fig. 298.



Gunshot perforation of kidney. (A. M. M.,
Spec. 1773.)

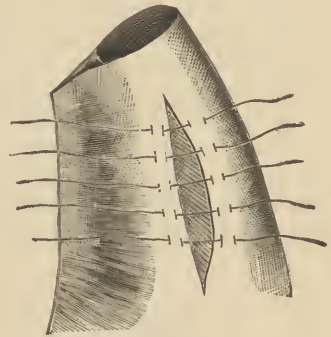
peritoneal extravasation of urine, yet generally cause death, from shock, from hemorrhage, or from extra-peritoneal abscess. Recovery however may take place. A number of non-fatal cases have been reported, but in a considerable proportion of them there is more or less reason for doubting the correctness of the diagnosis. In a Crimean case, observed by Legouest, in which the bullet had passed through the middle of the kidney from before backwards, it was found upon making an autopsy that "the organ was much diminished in size, and presented in the centre of each surface a firm, fibrous, depressed cicatrix, to which there were attached like the rays of a star five other irregular cicatrices."

TREATMENT OF GUNSHOT WOUNDS OF ABDOMEN.—The treatment of *non-penetrating* abdominal injuries must be conducted on general principles: foreign bodies are to be removed, when it is practicable to do so; hemorrhage is to be arrested—by ligation, if the bleeding is from one of the larger vessels; collections of blood, if not duly absorbed, are to be freely laid open, to prevent the formation of abscesses with resulting danger to the peritoneum, either from extension of inflammation by contiguity, or, what however rarely occurs, by the discharge of pus into the cavity; extreme quietude is to be maintained; and a strict diet enjoined. If the *kidney* has been wounded, free drainage must be secured, and any external collections of urine or pus which result, must be early and thoroughly evacuated. By the judicious administration of opium, by cold applications, and by bandage compression, peritonitis may be prevented or largely controlled.

In *penetrating* wounds, surgeons have until recently been content to apply cold; to put on a bandage—even of plaster of Paris (Neudörfer); to maintain absolute rest; to prescribe a sparing liquid diet, and opium internally, until the inflammation has subsided. The administration of morphia has been pushed to such extremes that in many cases it has become a serious question whether death has resulted from the wound or from the treatment. But the excessive mortality of these injuries from hemorrhage, from acute septicæmia, or from rapidly developed, intense peritonitis, certainly indicates that something more should often be done, and this “something” must be in the way of operative interference. The experience of the last twenty years has clearly demonstrated that the laying open of the peritoneum is not as dangerous as had previously been thought; that this serous membrane is a great lymph sac that will absorb septic material most readily and rapidly; and that for the prevention of a fatal result from such absorption, drainage must be secured. Whenever then the symptoms clearly indicate that extensive bleeding has recently occurred, or is still taking place; that the stomach or intestine has been opened; or that there has been an intra-peritoneal extravasation of urine or of bile—it certainly seems to be proper, and the surgeon’s duty, to perform laparotomy, turn out all clots, tie such divided vessels as can be found, sew up the opening or openings in the intestinal tube, thoroughly cleanse the cavity, and provide for the ready outflow of any fluid that may afterwards be poured out. As declared by McGuire, “If it is urged that the means suggested are desperate, it can be said in reply that the peril is so extreme that, as now treated, nearly all die; and I believe, by the means I have pointed out, in gunshot wounds of the peritoneum, the patient will exchange an almost certain prospect of death for at least a good chance of recovery.”

In closing wounds of the stomach or intestines, the ordinary continued suture (Fig. 226, page 29) may be employed, or preferably that of Lembert (Fig. 299) or that of Gély (Figs. 300, 301, 302). Whether or not the edges are freshened, is pro-

Fig. 299.



Lembert's suture

Fig. 300.

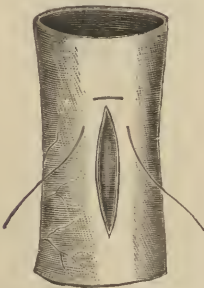


Fig. 301.

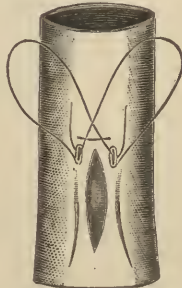
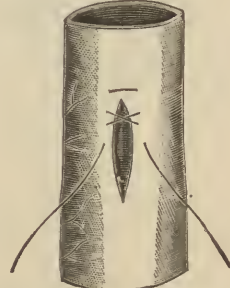


Fig. 302.



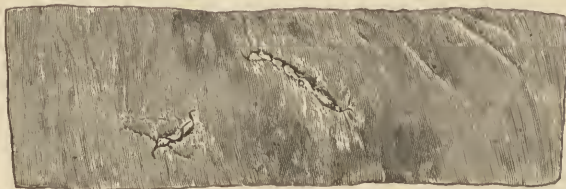
First, second, and third steps of application of Gély's suture.

bably a matter of little or no importance, since the union must take place between apposed serous surfaces. Silk or catgut sutures may be employed, the latter having the advantage of ordinarily entirely disappearing, but the

disadvantage of, at times, melting down before the union is sufficiently firm to be permanent.

If protrusion of an *uninjured portion of omentum or bowel* has occurred, and the case is seen when the parts are only congested, the hernia should be reduced, the parietal wound being enlarged if necessary, and being afterwards firmly closed by compression or with stitches, so as to prevent reprotrusion

Fig. 303.



Gunshot perforations of ileum closed with sutures. (A. M. M., Spec. 4390.)

which is otherwise very likely to occur. If *strangulation* has taken place, the knuckle of intestine is to be returned within the cavity, or not, according as its vitality is or is not likely to be maintained; the omentum should be left in place, though the great mass of the protrusion may very properly be ligatured and cut away. This plan of treatment should also be adopted in cases of hernia of portions of the liver, spleen, kidney, or pancreas.

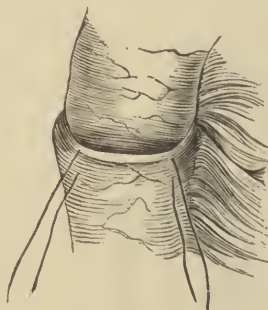
When an *artificial anus* has been formed, an attempt should always be made to close it, since, even if the operation should be unsuccessful, there will generally follow a marked reduction in the size of the opening, and the after condition of "fecal fistula" will be much less annoying. If necessary, the intestinal ends may be retrenched, and then sutured together,¹ or the upper end

Fig. 304.



Suture of bowel by Jobert's method; the threads are in place, and the mesentery dissected preparatory to invagination.

Fig. 305.



Upper end of bowel invaginated within inverted lips of lower end. (Jobert's method.)

may be simply invaginated within the lower, as in Jobert's method (Figs. 304 and 305). If an *éperon*, or spur-like septum, is present, which is much less

¹ In a case reported by Kinloch, of Charleston, S. C., in which this was done, half an inch on one side of the opening and two inches on the other having been removed, the continuity of the bowel was in a week later so well re-established, that the patient had a feculent stool *per rectum*, though this channel had been previously unused for seven months.

likely to be the case than when the artificial anus is due to causes other than gunshot injury, it must generally be destroyed; and use may then often be advantageously made of some form of enterotome or compressor, such as Dupuytren's (Fig. 306) or Gross's (Fig. 307).

Fig. 306.



Dupuytren's enterotome.

Fig. 307.



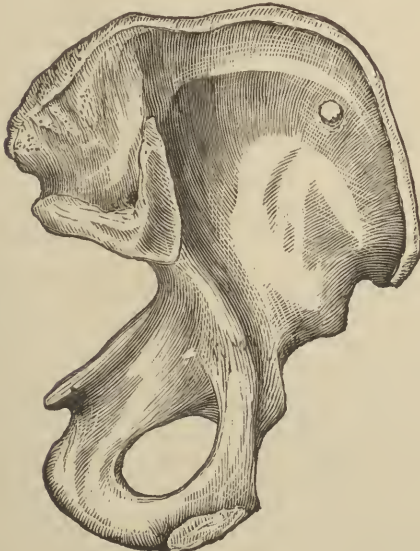
Gross's enterotome.

GUNSHOT INJURIES OF THE PELVIS.

In wounds of this region, damage may be done only to the external soft parts; or there may be associated injury of the innominate bone or sacrum, with or without penetration of the pelvic cavity; or penetration or perforation may occur without any accompanying bone lesion. Not infrequently, the wound involves also the abdomen or the genitals. Lodgment of the missile often takes place—in the thick external muscular mass, in the bone, somewhere in the cavity, or even in the bladder or rectum. As the result of shell injury, great destruction of the overlying soft parts is produced, at times in non-fatal cases; and frequently extensive shattering of the ilium is to be noticed, even in wounds from musket balls.

Lesions of the *bladder* may be expected to be followed by urinary extravasation, intra- or extra-peritoneal according to the location of the vesical opening; a bullet, or a piece of bone, may, however, ultimately work its way by

Fig. 308.



Gunshot perforation of left ilium. (A. M. M., Spec. 2217.)

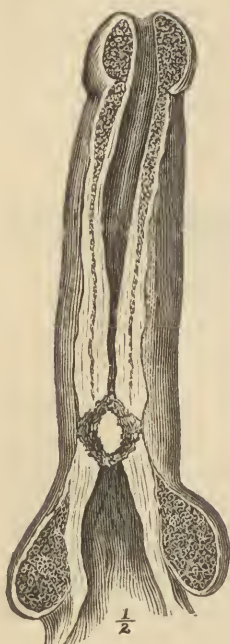
Fig. 309.



Gunshot perforation of bladder. (A. M. M., Spec. 510.)

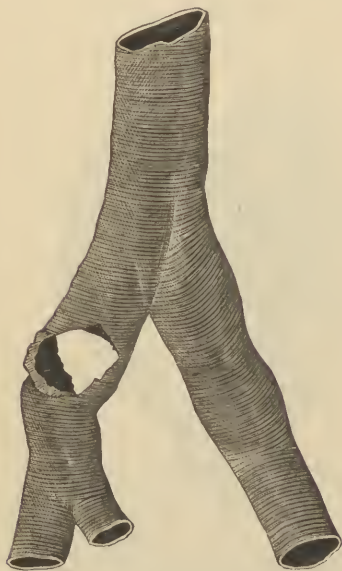
ulceration and absorption into the cavity, without there having been any escape of urine. Contusion of the hypogastrium may cause temporary paralysis of the bladder, or even permanent incontinence, as in the case reported

Fig. 310.



Gunshot perforation of penis, dividing urethra. (A. M. M., Spec. 902.)

Fig. 311.



Gunshot perforation of right common iliac artery. (A. M. M., Spec. 6336.)

by Williamson. When the *rectum* has been opened, fecal matter may pass into the peritoneal cavity or the connective tissue of the pelvis, or may be discharged externally, according to the position and extent of the wound. Not very seldom there is simultaneous perforation of both bladder and rectum; or at a later period a communication may be established between these viscera by sloughing.

Injuries of the *male generative organs*, which are fortunately not very common, may be either superficial and slight, or may involve the testis, penis, or spermatic cord. The *testis* may be bruised, torn, or completely carried away, and in cases of other than entire destruction atrophy is the usual result of the lesion; much less frequently, severe and long continuing neuralgia is produced. At times, the shot buries itself in the scrotum. The *penis* may be perforated, or penetration may occur with lodgment of the shot, which, if unremoved, may become encysted. The urethra, which is very apt to be involved, may be contused or lacerated, the injury ultimately resulting in the establishment of a very troublesome fistula, penile, perineal, or rectal, or in the formation of a stricture. Occasionally a ball, even of large size, will be found to have passed through the corpora cavernosa or the glans without damaging the urethra.

Wounds of the *female genitals* are rare, and usually associated with other and much more important lesions of the abdominal, pelvic, or femoral regions. The *uterus* is not often injured; when in the unimpregnated state, but little harm may be done beyond that resulting from the commonly associated vesical and rectal wounds; but when, on the other hand, pregnancy exists, there is much risk of an early and fatal termination of the case, from the abortion which must almost of necessity occur, or from hemorrhage, shock, or peritonitis. Death, however, may not take place; and even an injured fœtus may be born alive, if we can credit such a report as that given by Reichard.¹ A more or less permanent fistula may remain after an otherwise complete recovery from a penetrating uterine wound, through which the menstrual blood may be discharged.

The great *bloodvessels* of the region (iliac, gluteal, sciatic, pudic, or obturator) may be primarily divided, or secondarily opened by ulceration, after contusion; and traumatic aneurisms are at times developed. The large *nerves* (the sciatic within or without the pelvis, the anterior crural, the obturator) may also be injured, with resulting paralysis or neuralgia.

¹ In this case the child had a wound under the right clavicle, in which there was lodged a piece of the mother's clothing, and a buckshot of the size of a small pea.

DIAGNOSIS OF PELVIC INJURIES.—The only doubtful point, as a rule, in regard to diagnosis, is whether or not there has been perforation of the rectum or bladder, or both; and here, as in abdominal wounds, reliable evidence is furnished solely by the escape of the contents of the injured viscus—that is, of fecal matter or of urine. Whether or not the bladder is wounded, depends, in great degree, upon its full or empty condition.

PROGNOSIS OF PELVIC INJURIES.—The prognosis in injuries of this region is largely affected, of course, by the presence or absence of fracture or penetration. Flesh wounds, though they may cause death from hemorrhage, are, even when very extensive, not likely to terminate fatally, though they are not infrequently followed by decided functional impairment from muscular injury and cicatricial contraction. When fracture has taken place, the gravity of the injury is much increased; since, aside from the effects of the often-associated visceral lesion, the patient is subject to all the risks arising from prolonged suppuration and septic infection. Of the cases observed during our late war, those of fracture of the ilium were the least fatal—the expanded wing of that bone being at times bored through without serious damage being done—and those of the pubis the most so; the relative order being: ilium, 24.42 per cent.; coccyx, of which, however, only seventeen cases were reported, 35.3 per cent.; ischium, 42.4 per cent.; sacrum, 43.7 per cent.; pubis, 50 per cent. When the shot passes through the thick gluteal mass, there is often much difficulty in securing free drainage, and, as a consequence, danger to life is proportionately increased. In the cases that recover, healing ordinarily takes place slowly, and extensive necrosis or caries is likely to occur, especially when the bullet has lodged. When the shot has passed through the pelvic cavity, though it may, particularly if small, occasionally do no serious damage, yet usually visceral lesion is produced; but the mortality of such wounds is very much less than that which attends perforations of the abdomen, the probabilities of being able to secure free drainage being very much greater. Of 183 cases of bladder wound analyzed by Otis, 96, or 52.46 per cent., ended fatally, as did 44 of 103 cases of wound of the rectum, or 42.7 per cent.; in 34 of the rectal injuries, the bladder was also wounded, 14 of the cases proving fatal, or 41.17 per cent. When the bladder has been so wounded as to cause intra-peritoneal extravasation of urine, death is almost certain to occur, under the ordinary plans of treatment, from hyperacute peritonitis; and the same is true when fecal extravasation takes place through a rectal wound high up.

If recovery takes place after these visceral lesions, fistulae, strictures, or functional disturbances often remain. Very troublesome effects are at times produced by the entrance of pieces of clothing, wadding, or bone-fragments into the bladder or rectum, especially the former, or by the late consequences of necrosis. Foreign bodies may, in time, work their way out through the wounds or the natural passages; but osseous spicula, and particularly missiles, projecting into or free in the vesical cavity, may be expected to become incrustated with phosphates and to form the nuclei of calculi, which, occasionally, do not manifest their presence until years after the receipt of the wound. In at least sixteen cases of gunshot injury, stones have been formed upon bone-fragments, and in certainly thirty-three cases, the bladder has been opened and bullets or shell-fragments removed. In *genital wounds*, death, when it occurs, is usually due to other associated lesions; of the cases reported during our war, the mortality rate was: for wounds of the testis, 66 out of 586, or 11.26 per cent.; for those of the penis, 41 out of 309, or 13.27 per cent.; and for those of the urethra, 22 out of 105, or 20.95 per cent. *Extravasation of urine* following gunshot wounds of the urethra, like that following

injuries of other kinds, may be in large amount, with corresponding extensive destruction of tissue, or in limited quantity, with resulting abscess and fistula. When the large intra-pelvic *bloodvessels* are primarily opened—and this is more likely to happen in civil than in military practice, the wounds being made at shorter range—speedy death generally occurs, and the same result is very likely to follow similar injuries of the gluteal and sciatic vessels at or near their points of emergence. Secondary hemorrhage from ulceration may occasionally—though, unfortunately, not very often—be controlled by pressure or ligation, and the patient saved.

TREATMENT.—The treatment of *external* pelvic injuries is to be conducted on general principles: hemorrhage being controlled by compression or ligation; all foreign bodies, particularly detached bone-fragments, removed if possible; drainage secured; pus-collections opened; and rest maintained. Sequestra are to be taken away as they become detached, and various parts may often be advantageously removed with the gouge. When *penetration* has occurred, bullets, clothing, wadding, and spicula, driven in by the shot, are to be removed as they can be found. If the *rectum* has been wounded, much benefit will often result from free division of the sphincter, as recommended by Dupuytren. Extra-peritoneal *effusions of urine* are to be evacuated by perineal incisions, and a catheter should be carried through the urethra into the bladder and there retained; all abscesses are to be early and freely opened. When the vesical wound is so located that the urine escapes into the peritoneal cavity, death, as we have already seen, quickly takes place from peritonitis; and treatment by catheterization, with or without perineal section, cannot be expected, except by the merest good fortune, to avert the fatal result. Vincent has lately shown experimentally that recovery might be hoped for from laying open the abdomen and closing with sutures the wound in the bladder; and such an operation, together with, if necessary, the establishment of a connection with the rectum near the bottom of the recto-vesical pouch, would be certainly justifiable.

When the *scrotum* has been contused, or only superficially torn, no special treatment is required; any resulting inflammatory or purulent collections should be opened early. A wounded *testis*, even if extensively lacerated, should not be removed, since a portion of the organ may be ultimately saved, and the danger to life from expectant measures is less than that from operation—11.9 per cent. as against 18 per cent. in the cases treated during our war. When the *penis* has been wounded, treatment must be directed to the arrestation of hemorrhage, the prevention of urinary retention or extravasation, the preservation of every portion of the organ that can be saved, the controlling of the erections (which are, at times, excessively painful), and the correction, at a later period, of cicatricial incurvations arising from unilateral loss of substance. Hemorrhage, much more likely secondary than primary, is to be checked by ligation, if the dorsal artery has been divided, or, under other circumstances, by compression or the introduction of stitches, a catheter being kept in the urethra; or even by styptics. Whatever the part of the organ that is damaged, except when the wound involves only the skin, a soft catheter should for some days at least be kept in the bladder; and especially should this be done when the urethra has been divided, if it is not, as occasionally happens, impossible to introduce the instrument. If urinary infiltration occurs, it must be at once relieved by incisions. Retention, when catheterization cannot be effected, can always and safely be treated by suprapubic aspiration.

Amputation of the penis should not be performed, even if the organ has been almost completely cut through; for by the application of stitches the

parts may be so held together that at times union will result; as in the case reported by Baudens, in which "the cavernous bodies and the urethra, entirely divided, were held only by a portion of the integument." The always troublesome and often very painful erections must be controlled as much as possible by the usual remedies—opium, camphor, the bromide of potassium, etc. Cicatricial curvatures, which more or less seriously interfere with the functional integrity of the organ, if they cannot be prevented by appropriate dressings during the stage of healing, may be in greater or less measure corrected by removal of the cicatrix, if superficial and occupying the dorsum of the penis, or, when laterally placed, by excision of a wedge-shaped piece from the opposite uninjured corpus cavernosum. Urethral fistulæ and strictures should be treated in the usual way. When the abnormal openings are located in the penile portion, particularly near the peno-scrotal angle, or in communication with the rectum, failure is not unlikely to follow any attempt at closure.

For the arrestation of *primary hemorrhage*, if from even the large arterial or venous trunks—should cases of such come under treatment—ligation is always to be employed when practicable; the only exception to this rule is, perhaps, when the wound is of the gluteal artery, in the external part of its course, when properly applied compression may be used instead. Frequently it will be found very difficult, if not impossible, to determine from what source the bleeding comes; for instance, if the ilio-lumbar artery has been wounded, as in cases observed by Hodgen and Desprès. If an *aneurism* has formed, the sac may be opened and the vessel tied above and below, hemorrhage at the time being prevented by pressure on the vessel higher up, or by the use of an aorta compressor or a Davy's rectal lever. *Secondary hemorrhage*, whenever it is possible, should be treated by the application of ligatures above and below the seat of injury. Unfortunately, neither ligature nor compression succeeds in the majority of cases in saving life, and this whether the hemorrhage be primary or secondary. Not once after gunshot injury has a ligature been successfully applied to the common iliac artery. Every case of wound of the sciatic artery, during our war, terminated fatally, as did fourteen out of eighteen of those of the gluteal, two only being saved by ligation and two by compression. Of the sixteen ligations of the external iliac artery, only two ended in recovery.

GUNSHOT INJURIES OF THE VERTEBRÆ.

Gunshot injuries of the spinal column may produce contusion, fracture, or penetration of the canal, and are often associated with lesions of important structures in the neck, chest, or abdomen. *Contusion* may be caused by the blow of a large missile, with or without accompanying wound of the soft parts, or by a bullet, the momentum of which is so far destroyed that it is unable to break the bone. *Fracture* may affect either the processes or the body of a vertebra, and in the latter case the shot may either penetrate or perforate, producing very frequently fissures running through to the posterior surface. When the cervical or dorsal canal is *penetrated*, the cord is usually, though not necessarily, damaged, and the associated injury to the bony wall may be limited to one of the vertebral laminae. *Hemorrhage*, either outside or inside of the theca, may be associated with any of the forms of vertebral injury; and the same is true of *nervous disturbances*, such as pain (near or remote), tingling, reflex movements, and impairment—sometimes extending even to complete though temporary abolition—of motion and sensation. Laceration or division of the medulla must, of course, be followed by *paralysis*,

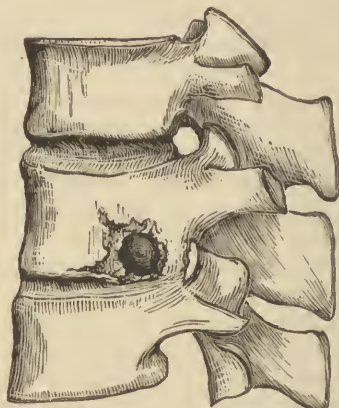
more or less complete, according to the locality and extent of the injury; and similar effects, confined to a limited area, may be due to lesion of a nerve soon after it has left the cord. At times, injury is done not by the missile itself, but by bone-fragments, detached or adherent, driven in by the shot.

Fig. 312.



Eighth, ninth, and tenth dorsal vertebrae, with conoidal ball in vertebral canal. (A. M. M., Spec. 2939.)

Fig. 313.



Round musket-ball lodged in second lumbar vertebra, after traversing abdominal cavity without injuring the viscera. (A. M. M., Spec. 3349.)

Meningitis, or *meningo-myelitis*, is the almost necessary consequence of any spinal injury other than the slightest, and is the chief cause of death in cases that survive the first few days after the receipt of the wound. A chronic form of inflammation may result even from contusion; but in most cases of the latter injury, the cord lesion is limited to concussion, which ordinarily is quickly recovered from.

DIAGNOSIS OF SPINAL INJURIES.—That a vertebral wound has been received, is indicated by the apparent line of direction of the shot, by the resulting shock, by the development of nervous disturbances, by the discovery upon exploration of broken bone, and by the detection of such associated displacement as is pathognomonic of a fractured spine however produced. The first of these indications has no value except as confirmed by the others, since deflection may and often does occur, particularly if the missile is small; and the second is little if any more reliable, since shock may be very slight, as at times when a spinous process is broken, and, on the other hand, it may be present in an extreme degree when the shot, passing near to but not impinging on the spine, has wounded important organs in its vicinity. Nor can paralysis or pain, whatever their character, location, or degree, be accepted as proof positive of fracture; pain may be due simply to contusion, or may be altogether absent (except such pain as may follow the receipt of any gunshot wound), particularly when it is a spinous process that has been broken. The existence of the latter form of injury can usually be readily ascertained by manipulation, both preternatural mobility and crepitus being detected. Escape of the cerebro-spinal fluid is usually associated with, and so far indicative of, injury of the cord; but such an outflow may take place when only the sheath has been opened.

Actual lesion of the cord from concussion, from compression, or from laceration by bone or ball, is always, except occasionally when the injury is in the lumbar region, followed by disturbances of sensation and motion, of the same character as those resulting from spinal irritation, inflammation, or disorgan-

ization after ordinary traumatisms. Pain, at times excruciating, may be present at the seat of injury, girdling the body, following the course of particular nerves, or confined to a limited area in a remote part; the sensation is not infrequently that of burning or tingling, or, on the other hand, there may be numbness or even complete anæsthesia. Similarly, the motor disturbances may be those of excess or diminution of action—twitchings, jerkings, tetanic spasms, or, what is much more usually seen, paralysis, partial or complete, below the seat of injury, transitory or permanent according to the condition of the cord—accompanied by muscular atrophy, most strongly marked in the leg muscles after lumbar injury. In cervical and dorsal wounds, the voice, respiration, and circulation are affected, in greater or less degree, according to the location and extent of the injury. Rectal and vesical paralysis, with subsequent incontinence, are ordinarily present if the cord-lesion has been at all extensive. In the male, priapism is an often-observed, but not necessary, symptom of injury above the third lumbar vertebra, its frequency of occurrence increasing as the wound approaches the top of the column. In cervical lesions, high up, seminal ejaculation is apt to take place at the time of injury, even when the wound causes immediate death. As in all other spinal injuries, bedsores are usually formed in cases that do not speedily prove fatal, and are likely to be developed very quickly.¹

PROGNOSIS.—The prognosis of vertebral injuries, aside from the less severe forms of contusions and fractures of the processes, especially the spinous, is very grave, death usually resulting from lesion of the cord, from septic infection, from caries with abscess, or from associated wound of a viscus or large vessel. As was declared by Ollivier, in gunshot cases the accidents are graver, and death generally more rapid, than in those otherwise caused. Of the 32 cases of vertebral fracture among the British soldiers in the Crimea, all proved fatal except four, “which were either fractures of the transverse processes in the neck, or of the spinous processes only,” and in the French army, 181 died out of 194 (93.3 per cent.). In the war between Prussia and Hanover, in 1866, there were eight cases with six deaths. Of 628 cases tabulated by Otis, 349 or 55.57 per cent. ended in death, the mortality according to locality having been: for the cervical region, 70 per cent. (63 out of 90); for the dorsal region, 63.5 (87 out of 137); and for the lumbar region, 45.5 per cent. (66 out of 145); but in almost all, probably, of the non-fatal cases, the fractures affected only the processes. Of the subjects of lumbar injuries, 79 recovered, but it is expressly stated that “there were more than seventy recoveries after gunshot fractures of the apophyses of the lumbar spine.” In Circular No. 6, S. G. O., 1865, it is reported that “of 187 recorded cases of gunshot fracture of the vertebræ, all but seven proved fatal; six of these were fractures of the transverse or spinous apophyses.” Of 54 cases in which it is known that there was an associated injury of the cord, 42 died (77.78 per cent.).

In very many of the military cases, death occurs so speedily that the individuals never come under observation. How quickly life may be destroyed is indicated by the fact that in a case of pistol-ball wound between the axis and atlas, the victim, who was asleep, was not startled by the noise of the firing, and never moved a limb.² The lower down in the column that the wound is, the longer of course the patient may be expected to live. Even when there has been a primary, complete division of the cord, the fatal ter-

¹ In a case observed by Guersant, in which the ball passed through the body of the eighth dorsal vertebra, a sacral bed sore formed on the third day.

² Specimen in Middlesex Hospital Museum.

mination may be delayed for hours or days, according to the wound's location. In injuries of less severity, affecting the medulla, its coverings, or the vertebral bodies, though death is very probable, it is not inevitable, and is less to be apprehended in cases occurring in civil life than in those met with in military practice, since the missiles used in civil life are ordinarily smaller. Complete restoration to health, in cases other than those in which the processes only are affected, rarely occurs, more or less nervous disturbance (pain, weakness, or positive paralysis) usually remaining during the after-life of the individual, with perhaps caries and abscess, or fistulae communicating with dead bone. When the injury has involved only a spinous process, and there has been no associated damage of the cord—which is frequently, if not generally, the case—the chances of recovery are very good. Even when the body of a vertebra has been broken—and under such circumstances considerable comminution may be expected to occur—if there has been no lesion of the cord or theca, other than perhaps a limited extravasation of blood outside the sheath, or a concussion of the medulla, the individual may not only not die, but may recover, and with very little after-disturbance, organic or functional.

In a case reported by Keen, a conoidal ball entered through the right upper lip and lodged in the body of the third cervical vertebra, from which place it was extracted six weeks later. The paralysis which had affected all four limbs was rapidly recovered from. Five weeks after the removal of the bullet, there was spontaneously discharged “nearly the entire body of the third cervical vertebra, including the anterior half of the transverse process and the vertebral foramen.” Nearly eight years afterwards the man was living, having his “right shoulder and arm diminished in size and partially paralyzed.”

Such a fortunate result, however, occurs only in young persons or in those not beyond middle life. *Contusion of the bone* may be followed by temporary and quickly recovered from general disturbance, or, after a few days, may give rise to meningo-myelitis, soon terminating in death; but inflammation is much less likely to occur here than in the head after cranial contusions, on account of the greater protection afforded by the subarachnoid fluid. Wounds of nerves close to the intervertebral foramina, will be followed by serious effects, motor and sensory, in the parts which they supply; and even concussion may give rise to paralysis and atrophy, the latter especially being likely to remain for a considerable time, if not permanently.

TREATMENT.—The special treatment of spinal injuries produced by gunshot has reference only to the removal, when practicable, of foreign bodies, such as balls, bone-fragments, shreds of clothing, etc. The wound should be explored as early and as thoroughly as possible by the finger, if it can be used, if not by the probe, in order that the presence or absence of fracture may be determined. Loose pieces of bone and clothing are to be taken away, and, if detected, the bullet also, provided that its removal can be effected by the exercise of warrantable force and in reasonable time; otherwise the shot is to be left undisturbed. Under no circumstances should any extensive cutting operation be practised in the search for a ball the location of which has not been ascertained by touch. Formal trephining has not as yet resulted favorably, but decided benefit has in some cases followed the elevation of depressed spinous processes and laminae. At times, the extraction of the missile may be followed by severe hemorrhage, necessitating the plugging of the wound. If an associated injury of an artery is causing troublesome bleeding, the vessel should if possible be found, and ligatures should be applied on either side of the opening. This complication is however a rare

one: in only seventeen cases of spinal injury during our war was there hemorrhage of any importance—but fourteen of these terminated fatally. In all other respects, the treatment of gunshot spinal injuries is the same as that of like accidents produced by ordinary traumatisms. The maintenance of rest, as absolute as possible, is very essential; and much benefit will without doubt be often secured by immobilization of the spine, preferably by plaster-of-Paris. Dry-cupping, in cases of concussion, and wet-cupping in those in which meningo-myelitis has supervened, have been regarded with much favor by many military surgeons. The bladder should be regularly catheterized; the bowels relieved at proper intervals; and bedsores prevented if possible by the use of the water-bed, by change of position, and by mildly stimulating local applications. Blood-poisoning, so much favored by the nature of the injury of a vertebral body, may perhaps be largely prevented by an antiseptic dressing. Paralysis, not disappearing speedily and spontaneously, should be treated in the usual way.

GUNSHOT INJURIES OF THE EXTREMITIES.

By far the larger part of the gunshot wounds coming under treatment in time of war,¹ and a very considerable though decidedly less proportion of those met with in civil life, are of the extremities; injuries of the lower, are about one-half more numerous than those of the upper extremity, and the general mortality is between 20 and 25 per cent. for the former, and about 12 per cent. for the latter. The left side is more often wounded than the right. As in other regions, the injuries may involve the soft parts only, or the bones and joints may also be damaged—the gravity of any wound being, as a rule, proportionate to the extent of the existing osseous or articular lesion. Joint wounds have already been considered. (See page 155.)

UPPER EXTREMITY.

FLESH WOUNDS of this region, though very frequent,² and liable to be followed in large proportion by more or less disabling cicatricial contractions and adhesions, are, when there is no associated wound of the neck or trunk, dangerous to life only as they are very extensive (as for instance when caused by heavy shot, shell fragments, or fowling-piece charges at short range), as they involve the main vessels, or as they are attended by the graver wound-complications.

The *treatment* therefore, aside from that proper for all gunshot injuries—the discovery and removal of foreign bodies, maintenance of rest, moderation of inflammation, relief of tension, drainage of the wound, etc.—has reference to the arrestation of hemorrhage, the meeting of special symptoms as they may arise, and the exercise of such care in dressing as shall prevent or lessen as far as possible cicatricial deformity and false ankylosis. *Divided arteries*, if other than small ones, should be ligated above and below the point of injury; but even when thus treated, the probabilities of such cases terminating fatally are very great.

¹ Of over 130,000 cases tabulated by Longmore, nearly 67 per cent. were of the extremities—28 per cent. of the upper, and 39 per cent. of the lower; and Otis's table, including nearly twice as many cases more, 360,000 in all, shows that one-third of the entire number were of the upper extremity.

² "Over fifty thousand cases, or about a fifth of all the wounded reported by name, were returned as shot flesh wounds of the upper extremities." (Otis.)

During our late war, there were 15 ligations of the axillary in cases of flesh wound, with 12 deaths (80 per cent.); 76 of the brachial, with 21 deaths (27.6 per cent.); 20 of the radial, with 4 deaths (20 per cent.); and 10 of the ulnar with 3 deaths (33.33 per cent.).

The large *nerve trunks* are, fortunately, not very often injured (about once in every 600 cases perhaps), but when wounded, though the results are not serious as respects life, they are very grave as regards the after comfort of the individual and the usefulness of the limb.

Occasionally, because of extensive laceration of the soft parts (by shell fragments usually), of sloughing or gangrene of large extent, or of lesion of a main vessel, *amputation*, primary or late, has to be performed. Of fourteen such operations at the shoulder-joint, during our war, eight resulted fatally, or 57.14 per cent.; of fifty-four of the arm, twenty-seven, or 50 per cent.; and of fourteen of the forearm, three, or 21.43 per cent. In civil practice, removal of the limb can only be required when a load of shot has been driven through the axillary space, so destroying the vessels and nerves as to render it certain that even if saved the arm must be useless, or because of the super-vention of gangrene, or of secondary bleeding that cannot be otherwise controlled.

GUNSHOT FRACTURES.—Occurring much less frequently, but still often, and producing greatly increased risk to life, and far more ultimate interference with the functional utility of the extremity, are cases of bone injury, almost always fracture. *Bone contusion* has but rarely been observed in this situation, either because actually not present, or more probably because overlooked, the effects produced being of a mild character, and being attributed to the injuries done the soft parts. All the varieties of fracture heretofore referred to are met with in this region; fissures, comminutions, crushings, penetrations, perforations, etc.—but the results of such lesions are not as grave as those of similar injuries in the lower extremity. At times both arms are wounded, or even carried away, by a shot that does not touch the body.

Fig. 314.



Shell-fracture of humerus treated by excision. (A. M. M., Spec. 1738.)

After the battle of Antietam, I saw a young infantryman who, when in the act of firing, was struck by a shell that crushed the left arm and right forearm, necessitating double primary amputation. Similar injuries have been not infrequently observed.

Associated wounds of the neck or trunk are very common, and in such complications are often to be found the causes of death.

Nerves, especially those passing in close relation with the broken bone, and when the fracture is near an articulation, are frequently damaged, with resulting paralysis, atrophy, muscular contractures, pains, or numbness; and in the majority of non-fatal cases, a large part of the functional impairment met with after these injuries is due to such nerve lesions. In many cases, especially when the nerves distributed to the hand have been wounded, severe and quite persistent *causalgia* has sooner or later manifested itself. *Tetanus* is not very likely to supervene, even in hand injuries, having been met with in but 24 of the over 11,000 cases of this nature reported during our war.

Primary, and still more often secondary, *hemorrhage* gravely complicates many of these cases, and *traumatic aneurisms* are at times developed; the vascular lesions, too, are often, but much less frequently than in like wounds in

the thigh and leg, the cause of *gangrene*. Suppuration of the sac is more apt to occur in traumatic aneurism of the axillary artery than in that of any other vessel.

Sometimes, when the shot has produced great destruction of the humerus, or after an extensive exsection in continuity, a *flail-like* condition of the extremity has resulted; but such a "dangle-limb" may yet be quite serviceable, the individual being able, by muscular contraction, to bring up the lower against the upper fragment, and afterwards to execute many movements of the forearm. *Pseudarthrosis* is very seldom met with; but in the rare cases of simple gunshot fracture of the humerus, false-joint seems very likely to result: there were but five such cases recorded during our war, and in two of these there was non-union.

Prognosis.—The prognosis of gunshot fractures of the arm, though affected, of course, by the character and extent of the osseous lesion, and by any associated injury of the neck or trunk, may be said, in general, to be moderately favorable, and to become less grave in proportion as the wound is located further away from the body: humeral fractures are the most dangerous, while those of the bones of the hand are the least so.

Of nearly twenty-five thousand (24,200) cases analyzed by Otis, the numbers and death-rates were as follows:—

	Cases.	Deaths.	Mortality per cent.
Clavicle	520	44	8.46
Scapula	1423	177	12.44
Clavicle and scapula	103	24	23.3
Humerus	7888	1639	20.7
Radius	1450	115	8.0
Ulna	1568	126	8.0
Radius and ulna	1288	142	11.0
Bones of hand	9960	316	3.17

As shown by the above table, though injuries of the clavicle or scapula, separately, are less dangerous than those of the humerus, yet those of the two bones together are decidedly more so. In scapular perforations, much trouble and some danger are likely to be caused by collections of blood and pus, internal to and, from gravitation, below the bone; even lumbar ecchymosis is sometimes thus produced. The chief causes of death are hemorrhage, exhaustion, and septic infection. In those non-fatal cases in which the limb is saved, recovery is tedious, and may be expected to be associated, in greater or less degree, with deformity, adhesions and contractions of the muscles and fasciæ, atrophy, weakness, and true, or more often false, ankylosis of the joints. The amount of impairment of functional value will, however, in very many cases, depend greatly upon the treatment adopted, and upon the time at and during which passive and active movements of the injured parts are made, and the extent to which they are carried.

Treatment.—In the treatment of these cases, the first and most important question to be settled is, shall it be by amputation, by excision, or by expectancy? Primary *amputation* of a part or the whole of at least the *right* upper extremity, should seldom or never be adopted for a bullet-wound, no matter how extensive the shattering caused by the ball; this operation should, in military practice, be reserved for the severer shell injuries, and in civil life, for the similar lacerations produced by shot-charges fired at close range. Even if the brachial artery has been torn, amputation is not imperatively demanded. Though undoubtedly lives will, at times, be lost in attempts to save limbs, the importance of the arm is so great that it is often permissible to take the increased risk. Amputation at a later period may be necessitated,

of course, by wound complications; but, with the exceptions already referred to, the operation should be held in reserve as the complement of expectancy.

As based upon a far larger number of cases, and for every reason giving a nearer approximation to the legitimate death-rate of amputations in the upper extremity than the tables compiled chiefly from the Crimean returns, Otis's statistics are here presented.

TABLE SHOWING RESULTS OF AMPUTATIONS FOR GUNSHOT INJURIES OF THE UPPER EXTREMITY.

	PRIMARY.			INTERMEDIARY.			SECONDARY.			UNSPECIFIED DATE.			TOTAL.		
	Cases.	Deaths.	Mortality per cent.	Cases.	Deaths.	Mortality per cent.	Cases.	Deaths.	Mortality per cent.	Cases.	Deaths.	Mortality per cent.	Cases.	Deaths.	Mortality per cent.
Shoulder	485	117	24.44	157	72	45.86	66	19	28.78	119	28	23.53	827	236	28.53
Arm—upper third .	1338	183	13.67	347	108	31.12	173	46	26.59	82	21	25.61	1940	358	18.45
Arm—middle “ .	1162	143	12.30	348	93	26.72	162	35	21.60	58	13	22.41	1730	284	16.41
Arm—lower “ .	512	106	20.70	161	67	41.61	61	24	39.34	22	0	0	756	197	26.05
Arm—location not stated . .	247	170	68.83	46	34	73.91	15	9	60.	539	194	36	847	407	48.05
Elbow	32	2	6.25	5	0	0	5	2	40.	7	1	14.28	49	5	10.20
Forearm—upper third	296	26	8.77	128	31	24.22	55	9	16.36	10	0	0	489	66	13.50
Forearm—middle “	381	25	6.56	205	41	20.	80	8	10.	9	1	11.11	675	75	11.11
Forearm—lower “	294	28	9.52	100	21	21.	40	6	15.	17	1	5.88	451	56	12.41
Forearm—location not stated . .	36	18	50.	17	13	76.47	9	6	66.67	57	8	14.03	119	45	37.81
Wrist	55	5	9.	7	1	14.28	5	1	20.				67	7	10.45

To which may be added that “6870 cases of ablation of the digits only, gave a mortality of 2 per cent.; 413 cases, in which the metacarpo-phalangeal articulations were interested and ends of metacarpal bones removed, a mortality of 3.2 per cent.; 619 cases, in which corresponding metacarpals were removed with fingers, a mortality of 7.6 per cent.” (Otis.)

Early, formal *excisions* in continuity should not be employed, since they are dangerous to life, frequently necessitate after-amputation, and, if of any extent, are very likely to be followed by disabling deformities, or by false-joints, or dangle-limbs. On account of necrosis, however, excision may often, at the proper time, be very advantageously performed, and even an entire bone may sometimes be properly removed.¹

That the treatment by *expectancy* may result in success, loose fragments must be removed, thorough drainage secured, the limb immobilized, and septic infection prevented. How far the accomplishment of the latter object may require the adoption of a strict “antiseptic treatment,” the future must decide.

LOWER EXTREMITY.

FLESH WOUNDS of this region are of common occurrence and of exceptional gravity; they are at times of very large size, as when the thigh or the calf of the leg has been struck by a shell-fragment, or as the result of hospital gangrene. The *main vessels*—femoral, popliteal, or tibial—are frequently involved in the injury, by laceration, or, more often, contusion. Both artery and vein may be simultaneously wounded, or, on the other hand, both may

¹ It is interesting to notice that, in the only recorded case of complete exsection of the scapula after gunshot injury (F. H. Hamilton's, in 1866), the operation was a late one for necrosis. Early and extensive removal of portions of the shoulder-blade has been practised in quite a number of cases, three times by one operator, Chipault, of Orleans.

escape, though the line of direction of the shot apparently passes directly through them. Bullets, even of large size, occasionally traverse the popliteal space from side to side, without damaging either the hamstring tendons or the underlying vessels. Deep, penetrating or perforating wounds of the upper and posterior part of the leg are very likely to injure one or both tibial arteries, and, as a consequence, such flesh wounds, even when made by small pistol-balls, must be viewed with much solicitude. Whether the thigh or leg vessels are primarily torn or contused, but particularly when damaged in the latter way, their injury is very apt to be followed by secondary bleeding or gangrene, which, as Lidell has put it, "destroys more patients than all the forms of hemorrhage taken together, battle-field hemorrhage excepted."

The principal *nerves* of the limb are not seldom wounded, their injuries being followed by the ordinary results of severe nerve-lesions, and in addition, when the sciatic has been divided, at times by gangrene. As has already been mentioned, wound of this nerve was declared by Wyatt to be the special cause of *gangrène foudroyante*, a complication, however, by no means limited to the lower extremity, and not rarely found associated with visceral disease, particularly of the kidney.

In some cases the lesion is not confined to the extremity, but involves also the pelvis or abdomen; frequently a bullet passes through both limbs, and, when it does so high up, the genital organs may be injured at the same time. If there be no serious complication present, the shot-track may be expected to heal in due time; but if the ball has pierced the fascia lata, or the dense aponeurosis of the antero-external part of the leg, it will often be found that, in healing, the fascial opening does not close, and that hernia of the muscle is consequently permitted. Disabling cicatricial deformities are very likely to follow, if there has been any considerable loss of substance, and more or less impairment of motion often results from muscular adhesions.

GUNSHOT FRACTURES.—When the shot has caused bone injury, the lesion, though occasionally a contusion, is, in the great majority of cases, a fracture, and very rarely of the simple variety. When the missile has struck the lower end of the femur, or, much oftener, the upper end of the tibia, it may penetrate or perforate without splintering. Such a wound was not seldom witnessed in former times, when the round ball was used, but is only exceptionally produced by the modern conoidal bullet, even if of small size. In all such cases observed by Becher, during the Franco-German war, the vulnerating body was a Chassepot bullet. It is possible, but not very probable, that though a shot passing through an articular extremity at the knee may extensively comminute the bone, there may be no apparent change of shape produced, extravasated blood temporarily cementing the fragments together. Lodg-

Fig. 315.



Gunshot laceration of right femoral vein. (A. M. M., Spec. 2094.)

Fig. 316.



Partially consolidated gunshot fracture of left femur. (A. M. M., Spec. 798.)

ment of the missile may take place, much more frequently, in the case of the thigh and leg bones, in one of the epiphyses than in the shaft. Bullets thus lodged, if not removed, though they ordinarily prove a strongly exciting cause of early local mischief, may become encapsulated, and give rise to no trouble; but serious inflammation may be excited by their presence years subsequently.¹ When it is the tarsus that has been wounded, the ball, particularly if a small one, often buries itself in the cancellous tissue, or is wedged between two bones, from whence it may be removed only with much difficulty. In addition to the ordinary longitudinal or spiral fractures of the femur or tibia, there may be a transverse break at some little distance above or below the point of impact, according as the latter is below or above the middle of the shaft. (Otis.)

Pseudarthrosis is of less frequent occurrence, in these cases, than might naturally be expected from the extent of damage done by gunshot violence. Béranger-Féraud has collected the histories of fifty-six cases of non-union of the femur, and seventeen of the bones of the leg; and believes that such a condition is less often seen after wounds of the lower than after those of the upper extremity (in the proportion of eleven to twenty-four), not because of any difference in the parts themselves, but for the reason that attempts at saving the limb are so much oftener made in injuries of the arm and forearm than in those of the leg and thigh.

The *femur* is, of all the long bones, the one most frequently wounded, and that injury to which is most dangerous to life.² At times, when the lesion is in its upper part,³ the fracture may be readily recovered from with but little shortening or deformity. The causes of the great mortality attending this injury are: the hardness of the compact tissue and consequent extent of the shattering; the necessarily considerable hemorrhage that must occur, even if the larger vessels are uninjured; the deep situation of the bone, and its heavy muscular and fascial investments, much hindering the outflow of fluids; the abundance of lymph-vessels in the thigh; and the size and importance of the neighboring arteries, veins, nerves, and joints, one or more of which are so often associated in the lesion.

Tibial fractures, though less likely to terminate fatally than those of the femur, are yet very serious accidents, especially if of any considerable extent, and particularly if accompanied by fracture of the *fibula*. When the injury is a crushing one, and near the knee, rather profuse and troublesome hemorrhage is almost certain to ensue, even if none of the large vessels in the vicinity have been wounded. Great fissuring, longitudinal and spiral, is of frequent occurrence in this locality, and the fissures, though there may be so little separation of the fragments that prolonged walking is not at first prevented, may yet ultimately give rise to a fatal osteo-myelitis. Similar splitting of the fibula is much less often seen, the shot usually producing comminution or loss of substance ("exsection-fracture").

When the skeleton of the *foot* is injured, there may be great crushing, as from the blow of a piece of shell, or of a nearly spent large shot, or from the passage of a bullet, longitudinally or transversely, or the damage may be limited to one or two of the tarsal or metatarsal bones.

¹ Larrey reports a case in which a ball, buried in the lower extremity of the tibia for nearly thirty years, caused an osteitis that necessitated amputation.

² Of over 2000 cases of fracture of the femoral shaft occurring in recent wars, more than three-fifths ended fatally (2142 cases with 1289 deaths, or 60.17 per cent.). The mortality according to location was: in wounds of the upper third, 72 per cent.; in those of the middle third, 60 per cent.; and in those of the lower third, 53 per cent.

³ At least once such a result has followed a break lower down, viz., in Legouest's case of a young negro, wounded in the middle third of the femur, and who, in two months and a half, was able to walk, and had no shortening of the limb.

TREATMENT.—As in injuries of the upper extremity, the primary question, as respects treatment, is whether or not an attempt to save the limb can be made with reasonable prospect of a successful result, or at least with as much probability of preserving life as if amputation were performed? This question must be answered in the negative in cases of cannon-shot smash, and in those, in civil life, in which a small-shot charge has produced extensive laceration of the soft parts, comminution of the bone, and division of the main vessels or nerves. In cases of bullet *flesh-wound*, any other than the expectant treatment can be, at first, necessitated only by division of the femoral or popliteal vessels; and though, under such circumstances, there would be great danger of subsequent gangrene, and though intermediary operations are much more fatal than primary, few surgeons would be willing to do otherwise than apply ligatures and wait. Even if the femoral artery and vein were both wounded high up, a condition “that might be considered as absolutely necessitating immediate amputation,” the patient’s condition would probably be so feeble, from loss of blood, as to forbid an operation as grave as either disarticulation at the hip or amputation in the upper third of the thigh.

When the *femur* has been broken, whether or not *amputation* must be practised will depend upon the character of the fracture, its extent, its complications, and the necessity or otherwise of an early transportation of the patient from the place at which he has been wounded. If the shattering has been great, and the fragments are widely separated, with much accompanying tearing of muscle, primary amputation should be adopted, especially if the injury is located below the middle of the shaft; since, otherwise, the chances of recovery are but few, and, even if the patient survives, the preserved member is likely to be of little functional value, while very often necrosis will follow and ultimately compel removal of the limb, or prolonged suppuration may give rise to fatal visceral lesion. Associated injury of the femoral or popliteal *artery* or *vein* has generally, and with good reason, been held to indicate immediate amputation; but this operation is not always absolutely necessary, since experience has shown that after ligation of the vessel, gangrene may not occur; that repair of the osseous lesion may not be interfered with; and that, as in the case reported by Jobert (de Lamballe), the wound may heal with even less than the usual inflammation. If both artery and vein together have been divided, immediate amputation should if possible be performed above the level of the bone injury.

If the bone is only fissured, and this is likely to be the case in very many of the pistol-ball wounds of civil life, and in a considerable proportion of the injuries caused by the modern, elongated, conoidal bullet, the treatment should be by *expectancy*; the untorn periosteum serves to hold the fragments well in position, so that repair may take place rather quickly, if the development of osteo-myelitis can be prevented. Even in cases of comminution of moderate extent, by the early removal of detached splinters; by thorough drainage, with or without counter openings, according to the circumstances of the individual case; by immobilization of the whole extremity with plaster-of-Paris or wire splints;¹ by methodical compression over thick layers

¹ Decided advantage, as respects both the comfort of the patient and the ease with which the necessary dressings can be applied, will often result from *suspending* the immobilized limb. If immobilization is not made, as it always should be in one way or another, the treatment by suspension is very much better than any other, and some such apparatus as Smith’s “anterior” splint or, preferably, Hodgen’s splint should be employed. In leg-fractures, also, suspension is of much value. If any extending force or weight is put on in cases of comminution, it should be but a light one, simply steadying the parts.

of cotton; and by the adoption of all practicable measures, therapeutic and hygienic, to prevent the development of septic wound-complications, it is highly probable that, in the future, limbs and lives will be saved in much larger proportion than they have been in the past, and that this part of military surgery may prove much less unsatisfactory than heretofore.

As the result of Robuchon's investigations, it would appear that "4234 amputations of the thigh, done at Antwerp, at Paris (1830), in the Crimea, in Italy, in America, and in Germany (during the war of 1870), had a mortality of 77 per cent." Of Beck's 171 cases in the Baden army, during the Franco-German war, 103 died, or 60.23 per cent., the primary operations resulting fatally in 50.62 per cent. (41 out of 81), the intermediary in 84.73 per cent. (16 out of 19), and the secondary in 64.8 per cent. (46 out of 71). Of James's 155 cases treated in the Letterman general hospital on the battle-field of Gettysburg, 54, or 34.84 per cent., died; 74, or 47.74 per cent., were discharged, cured; and 27, or 17.42 per cent., when last heard from, were living, but not cured. Of 1597 cases reported in Circular No. 6, S. G. O., 1029 died, or 64.4 per cent.; the mortality according to location, as far as yet determined and reported, was: in the upper third, 75 per cent.; in the middle third, 54.83 per cent.; and in the lower third, 46.09 per cent.

Though the published statistics of the most important wars of the last thirty years are, unfortunately, as yet incomplete, it would seem that there had been, since the commencement of the Crimean war, a decided increase in the percentage of recoveries with preservation of limbs. Such reports as that from the field of Langensalza (38 cases with 28 recoveries, or 73.6 per cent.); as that from Stromeyer's field-hospital at Floing (34 cases with 24 probable recoveries, or 70.6 per cent.); and as that of Beck (131 cases of fracture of the femoral shaft with 87 recoveries, or 66.5 per cent.), certainly indicate that in military practice, *when the wounded can be duly watched and properly treated from the time of injury, and need not be transported*, conservatism will give decidedly better results than amputation. With very much greater probability of a satisfactory recovery, expectancy may be resorted to in fractures of the thigh occurring in civil life, and its adoption should, under these circumstances, be the general rule.

Formal *excisions* in continuity should not be employed, on account of the very great danger to life,¹ and the probable uselessness of the limb if death should not occur. A dangling arm may yet be a useful one; a dangling leg is almost always simply an incumbrance, whatever sustaining apparatus may be applied.

In fractures of the *leg* not involving the knee- or ankle-joint—these have already been considered—expectancy yields, in general, better results than operative interference. *Amputation*—which is, of course, to be performed when there has been a complete crushing of the foot or leg, and which may very properly be resorted to, but is not imperatively demanded, when there is associated injury of the tibial vessels, or when both bones have been extensively comminuted—has been followed, in military surgery, by a very considerable and, at times, an excessive mortality. The death-rate of 8117 leg amputations (4413 tabulated by Robuchon, of which 1981 were fatal, and 3704 reported by Chenu from the French armies during 1870–1, of which 3050 were fatal) was 61.98 per cent.—a rate increased nearly one-half by the frightful mortality of the French operations during the war of 1870–1, 82.34 per cent., or more than 10 per cent. in excess of that among the French in the Crimea.

¹ Of 47 cases tabulated by S. W. Gross, 41, or 87.23 per cent., ended fatally.

How greatly the death-rate of leg amputation varies at different times and among different troops, is shown by the following table from Chauvel: Siege of Antwerp, 22.7 per cent.; Paris (1830-1832), 62.5 per cent.; Denmark (1848-1850), 39.13 per cent.; Crimea (English), 34.52 per cent.; Crimea (French), 71.95 per cent.; Italy (Austrians), 74.29 per cent.; Italy (French), 66.57 per cent.; U. S. Army (1861-5), 26.02 per cent.; French (1870-1), 82.34 per cent.; Baden troops (1870-1), 35.4 per cent.; Hanoverians (1870-1), 36.5 per cent.

Primary *excision*, though it may be here performed with far better prospect of recovery than in the thigh, is not to be recommended, since, in the great majority of the successful cases, an equally good if not better result might, in all probability, have been secured with less risk by the simple removal of detached splinters. At a later period, for necrosis, resection of either tibia or fibula may very properly be employed in preference to amputation, and even after removal of a considerable part of the shaft—seven inches in one of Chipault's cases—much regeneration of bone may take place, and the patient may ultimately be able to walk very well with a little mechanical support.

Almost always in civil life, and generally in the uncomplicated bullet-fractures met with in time of war, the treatment should be by *expectancy*, the death-rate of which is from one-third to one-half that of amputation, according as the statistics of that operation are taken including or excluding recent French cases. Associated vascular or nervous lesions do not absolutely contra-indicate an attempt to save a limb, nor, as we have already seen, does even an accompanying wound of the knee or ankle. Traumatic aneurism, if it is developed, may be treated by ligation at the place of injury, or at a distance, on the proximal side—a method that answers decidedly better here than elsewhere. Venous hemorrhage, either primary or secondary, can generally be controlled by compression. The same treatment will often prove successful in cases of bleeding from the veins of the thigh, though the application of a ligature is surer and safer.¹ If, during the course of expectant treatment, the condition of the part or the general state of the patient renders it necessary, the limb can be removed, though with a greater probability of a fatal result than if the operation had been primarily resorted to.² Even at a much later period, amputation may have to be performed, on account of deformity, pain, or simple uselessness of the limb; and the greater or less likelihood of the part having little or no functional value, if saved, must be taken into consideration in determining at the time of injury whether or not an attempt at preservation shall be made. The existence, therefore, of severe nerve-injuries, which are so apt to be followed by neuralgias, by trophic changes, and by secondary deformities from muscular contractures, will much influence the surgeon in deciding upon a primary amputation.

While, however, it may be said, in a general way, that bullet-wounds of the thigh or leg should be treated expectantly rather than by operation, and while statistics support this statement, it must always be borne in mind that the value of numbers is apparent rather than real. The particular circumstances of the individual cases, and of the special military operations in which the wounds have been received, must determine the course of treatment to be adopted, and not the simple fact that in so many thousand cases, collected

¹ In a case reported by Desprès, of ligation of the femoral vein near the apex of Scarpa's triangle for secondary hemorrhage, "neither œdema nor pain followed, the ligature separated in six days, and the man rapidly recovered."

² Of Beck's 124 leg amputations, the mortality rate of the 66 primary operations was 33.33 per cent., of the 6 intermediary operations 66.67 per cent., and of the 52 secondary operations 40.38 per cent.

from numerous wars in different years and various countries, expectancy has yielded a higher percentage of recoveries than amputation.

Gunshot wounds of the *foot*, not involving the ankle-joint, are frequently met with in military practice, and occasionally—almost always as the result of accident—in civil life; and in a relatively large proportion of cases, fracture of one or more bones is present.

The *prognosis* of these injuries as respects life is not grave, though death may result from hemorrhage, from tetanus, or, much more generally, from septic complications. As respects, however, the after-usefulness of the limb, the gravity of these cases is quite considerable, for even if amputation, complete or partial, is not necessitated, muscular atrophy, tendinous adhesions and contractions, osseous deformities, or tender cicatrices, one or more, are very liable to seriously interfere with locomotion.

As a general rule, the *treatment* should be by expectancy, primary *amputation* being performed only when a part or the whole of the foot has been very extensively damaged. In toe-injuries, if amputation becomes necessary, it should be complete—at the metatarso-phalangeal articulation—except in the case of the great toe, of which any uninjured portion should be saved. In operating through the metatarsus or tarsus, no more should be removed than is absolutely necessary, and the skeleton of the foot may, with reference to amputations, be regarded as constituted of but a single bone. Amputations in contiguity are to be practised only when those further distant from the trunk, and in continuity, cannot be substituted; Chopart's operation is very likely, because of retraction of the tendo Achillis, to be followed by an unsatisfactory result as far as the comfortable use of the stump is concerned. The death-rate of amputations in front of the ankle-joint is not great, and that of amputations at the joint itself was, during our late war, but 13 per cent.—9 out of 69 cases.

Of 790 cases of toe-amputation, tabulated in Circular No. 6, S. G. O., only 6 or 0.76 per cent. terminated fatally; and of 119 partial amputations of the foot, only 11 or 9.24 per cent. Legouest's statistics, here as elsewhere, give a much higher mortality percentage, viz., 18.9 for the toe-amputations, 38.0 for partial removals of the foot, and 23.2 for disarticulations of the ankle. During the Crimean war, more than one-half (51.35 per cent.) of the cases of ankle-joint amputation among the French ended in death, while the proportion among the English was only about one-sixth (15.38 per cent.).

Expectant treatment in these cases must be conducted on the same general principles as in wounds of other regions. Lodged missiles, if of large size, should always if possible be found and removed, since their presence is almost certain to develop and maintain bone-inflammation.¹ When the injury, however, has been caused by a small pistol bullet, if the location of the shot cannot be determined by the use of the probe, no extensive incisions should be made in the hope of finding the ball. The ends of divided nerves and tendons, especially those upon the dorsum of the foot, may very properly be united with sutures. Hemorrhage, whether primary or secondary, if from any of the larger arteries, should be arrested by ligation, at the seat of injury, and not at a distance. Bleeding of a severe character is of frequent occurrence in these cases, and, if not properly treated, is very apt to produce most serious results. The dissection that may be required in order to find the wounded vessel will be much facilitated by the preliminary application

¹ Stromeyer declares that "injuries of the tarsus generally are not very dangerous, and heal with unexpected facility, and without perceptible exfoliation, after extraction of the bullet."

of the Esmarch bandage. Free drainage must be secured, and suppurative teno-synovitis—which is quite likely to occur, as it is also when amputation has been performed—must if possible be prevented. The foot should be immobilized in a proper position, and much attention should be directed to the prevention of cicatricial deformities. If tetanus should be developed, and it is relatively frequent in these cases, early neurectomy might prove of great benefit. Carious bone should be gouged out, or the affected bone or bones removed. Even the entire os calcis has in a number of cases been taken away, and recovery with a useful foot followed; and judging from the results of extensive, and even complete, excisions of the tarsus for caries consequent upon other causes, similar operations might very properly be substituted for amputation in cases of bone disease following gunshot injury.

VENEREAL DISEASES: GONORRHŒA.

BY

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THE word GONORRHŒA, although etymologically inaccurate as a designation of the disease in question, is still so universally employed and so well understood, that it has been retained in this article for the sake of convenience. The old English but now vulgar term "clap" is no better, lacking even the slight descriptive force of its French and German congeners, *chaude-pisse* and *tripper*. For reasons to be presently stated, *urethritis* will be used interchangeably with gonorrhœa, as the term that most precisely and comprehensively describes the most common manifestation of this malady, which, exclusive of the diseases of childhood, has probably affected at some time in their lives a larger proportion of the males of the community than any other single ailment. This extreme frequency—which will not be questioned by those who have had much opportunity of observation in this direction—of itself renders the disease of sufficient gravity to entitle it to careful consideration, even if the harmful consequences commonly attributed to its direct or indirect influence be denied.

HISTORY OF GONORRHŒA.

As to the *history* of gonorrhœa, which may be briefly dismissed, there is quite sufficient evidence to show that inflammation of the urethra, attended with purulent discharge appearing at the meatus, and capable of being transmitted from person to person by contagion—that is to say, of "gonorrhœa" precisely as we now know it—is a disease which has existed from the remotest periods of antiquity, the writings of Moses, of Herodotus and Aristophanes, of Celsus and Hippocrates, of Rhazes, Avicenna, and Albucasis, all containing more or less accurate descriptions of such a urethritis, which affected their cotemporaries, and which was then, as now, accompanied or followed by numerous complications.

The disease may be tracked across the middle ages with even greater facility, although it was then confused with the various manifestations of syphilis, and was not definitely separated from that affection until the early part of the present century, since which time the non-identity of these two diseases has been but rarely and feebly disputed. The only debatable ground in the consideration of gonorrhœa at this time is the question of its specificity, or invariable dependence upon a virus which is said to constitute the contagious element, and to impart to the disease such distinctive—"specific"—characters as clearly to separate it from other affections.

NATURE OF GONORRHOEA.

As this subject is not only of theoretical interest but of great practical importance, the views held influencing both prognosis and treatment, and sometimes important medico-legal opinions, etc., it will be useful to look carefully at both sides of it.

Those diseases which are called "specific," and which are recognized as distinct clinical or pathological entities, or as depending upon definite and invariable sources of origin, have, as a class, certain peculiarities which more or less accurately characterize them; they have a period of incubation intervening between the time of exposure to infection and the outbreak of the first symptoms; they cannot be caused by traumatic influences or by anything except the essential virus of the disease, which through some channel must find its way into the general circulation; they usually protect from a second attack; they are, in the majority of cases, accompanied by distinctive pathological changes or processes, which distinguish them from diseases the result of mere irritative action; they run a definite course, and, after their termination or subsidence, cannot be reawakened at will by any known agency.

In gonorrhœa, not one of these conditions obtains. There is no definite period of incubation—indeed, none at all, except that which always intervenes between the contact of an irritating foreign substance and the production of a sufficient degree of inflammation to excite subjective symptoms. A large number of widely dissimilar causes are capable of developing the disease in its greatest intensity; authentic cases are recorded of well-marked urethritis following accidental or experimental exposure to leucorrhœal discharges; to the pus from a healthy abscess, or from a purulent bronchial catarrh; to the secretion from an endo-cervicitis or endo-metritis; to the discharge resulting from ulceration or malignant disease of the uterus; to the menstrual fluid or acrid vaginal discharges; to powerful injections; to the passage of gravel; to catheterism; and to many other undoubtedly non-specific causes. The condition thus evoked is in no wise distinguishable from that following sexual intercourse with a person already having a similar disease, some of the most severe and most complicated cases of gonorrhœa which have fallen under the notice of the writer having been derived from one or the other of these sources. The assertion that in so-called "true" gonorrhœa the disease has a peculiar tendency to become chronic or to run into obstinate gleet, while on the other hand "simple" gonorrhœa, or urethritis, tends to subside spontaneously, cannot be admitted as an argument based upon clinical facts. It may be positively stated that no sound inference as to the cause, in any particular case, can be drawn from its course or symptoms, and that the variations observed in the different grades of urethritis are no greater than those which prevail among inflammations of other mucous passages, and which are due to individual idiosyncrasy, or to differences in the power of the original irritant.

So far from exercising any protective influence against subsequent attacks, gonorrhœa, like tonsillitis, laryngitis, bronchitis, enteritis, cystitis, etc., predisposes to them, often, especially if it has been protracted, leaving the urethra in an atonic, relaxed, or catarrhal condition, or else roughened, granular, and congested. It is exceedingly common to have patients remark that, although frequently exposed to contagion, they went many years without contracting the disease, but that since the first attack they acquire it every few months, which circumstance they usually attribute to "bad luck," or, not infrequently, to an imaginary necessity for conforming to a general average.

In observing the course of gonorrhœa from a pathological standpoint,

nothing whatever is found to occur, either as to the manner of attack or the tissue or tissues invaded, which separates it from ordinary catarrhal diseases; nothing, for example, analogous to the induration of the chancre, the ulceration of Peyer's patches, the dermatitis and pustulation, which, by their almost unvarying presence in syphilis, typhoid fever, and variola, are entitled to be called specific characters in those diseases.¹

The occasional occurrence of articular disease, "gonorrhœal rheumatism," and of a scleritis, "gonorrhœal ophthalmia," as complications of urethritis, has been frequently attributed to some peculiar property supposed to belong solely to gonorrhœal pus, and never originating apart from contagion. Since, however, it has been found beyond dispute that these inflammations of fibrous tissue may complicate urethritis due to traumatism, and that they are in all probability mild pyæmic manifestations following the absorption of purulent products through the delicate urethral mucous membrane (see p. 240), this argument has lapsed. The term "urethral synovitis" has been proposed as a substitute for the former, and is in every way preferable. The intense form of conjunctivitis following contact with pus resulting from a urethritis, has also been shown by experiment to be in no sense a specific process, pus from an eye affected with ophthalmia neonatorum having produced a characteristic urethritis, which in its turn proved transmissible, and gave rise to a typical conjunctivitis.

After gonorrhœa has apparently subsided, any indiscretion in diet, any sexual or alcoholic indulgence, any local irritation, may, and frequently does, serve to reproduce it in all its original intensity, and this may be repeated an indefinite number of times. Nothing at all analogous to this occurs during the course of any of the diseases with which we are comparing it. Unless the peculiar virus is supposed to be generated anew in each case of traumatic urethritis, an untenable theory, it becomes impossible in the light of clinical observation to explain these peculiarities and variations in the cause of gonorrhœa on the supposition that it is truly specific in its character.

The facts which have thus been stated may be briefly presented in a tabular form:—

GONORRHOEA.

No period of incubation.
Caused by a variety of agencies, chemical, traumatic, and infectious.
Predisposes to a second attack.
Associated only with ordinary processes of inflammation.
May be re-awakened or reproduced at will and indefinitely.

SPECIFIC DISEASES.

Definite period of incubation.
Caused always by the absorption of a definite virus or morbid product.
Protect from a second attack.
Have distinct and almost unvarying peculiarities as regards their pathology.
Run a definite course, and cannot be made to return after its completion.

Dr. Fordyce Barker speaks of a peculiar form of urethritis which has associated with it a leucorrhœal discharge, that in repeated instances has produced a purulent urethritis in the male. Dr. Otis records the case² of a gentleman who had been married

¹ "Chiefly affecting mucous membranes, gonorrhœa has all the characters of ordinary inflammation of mucous membrane; it begins near the surface where the contagious secretion is first applied, and thence spreads towards the interior of the body; it is attended by redness, with scattered or more general hyperæmia, swelling of the mucous membrane, considerable increase in the secretion of mucus, with the addition of many wandering leucocytes, and, in severe inflammation, also of red corpuscles; subsequently the swelling, hyperæmia, increased mucous secretion, and escape of leucocytes diminish, the superficial epithelium desquamates, and the secretion of mucus gradually abates. Such are the anatomical characters, and they are those of any catarrhal inflammation."—Prof. H. Lebert (a strong advocate of the doctrine of specificity), in Ziemssen's *Cyclopædia of Practical Medicine*, vol. viii. p. 752.

² *Medical Record*, June 8, 1878.

one year, and in whom a urethritis had appeared soon after his marriage. This disappeared under treatment, but subsequently redeveloped three or four days after each sexual congress with his wife. Upon examination it was found that she suffered from retroversion of the uterus; that the surface of the external os was eroded, and covered with a thin layer of muco-purulent material. The uterus was restored to its normal position and retained by a pessary. The lady made a prompt recovery, and from that time the gentleman suffered no more from his urethral trouble.

Mr. Milton, an ardent supporter of the theory of specificity, admits¹ that "urethral discharges do appear in men as the result of connection with women laboring under leucorrhœa," but says that such a discharge is "*usually* much milder than gonorrhœa in its symptoms," which we have no doubt is true. We may also agree with him that "even a slight amount of gonorrhœa is more likely to excite the same disease in another person, than a pretty high degree of leucorrhœa is to bring on a simple urethritis." Leucorrhœal discharges are sometimes almost entirely mucous, and in such cases are probably innocuous. Gonorrhœa, in the sense in which he uses the term, always contains pus, which is undoubtedly the most active and most frequent source of urethritis, only it need not be in any sense "specific."

Unquestionably the strongest argument urged in favor of the specificity of gonorrhœa, is the fact that those married men who refrain from intercourse with other women than their wives, enjoy comparative immunity even although the latter are the subjects of leucorrhœa. There can be no doubt that in the vast majority of cases such men either escape all forms of urethral inflammation, or at the most suffer from a catarrhal urethritis, and rarely or never develop an acute, inflammatory condition. This as a clinical fact is denied by no one, but was explained by Ricord on the theory of "acclimation;" the husband is said to become "seasoned" or accustomed to the discharges of the wife, so that they have no effect upon him, although at the same time, as is shown by many authentic cases, they may give rise to a violent gonorrhœa in a third person. This is doubtless also true to a great extent, yet it hardly seems to me entirely satisfactory, or to explain, for instance, the escape of those men who marry women already affected with leucorrhœal discharges, and who, of course, are not already "acclimated." Great numbers of such marriages continually occur, and yet it is very rare, at least among well-to-do people, to find the husband developing gonorrhœa, even although the predisposing influence of the sexual excesses not uncommon in early married life be added to the possible exciting causes existing in the woman's condition. In dispensary practice, however, it is not so exceptional an occurrence, and is occasionally a source of domestic discord. I have seen several such cases within the last year. Here again it must in fairness be admitted that the women concerned are hardly above suspicion; and although it is the duty of the physician under the circumstances to give the woman the benefit of any doubt as to the precise character and cause of her ailment, it cannot be denied that the doubt frequently exists. The only explanation of these facts which seems in accord with the various powerful arguments in favor of the non-specific character of gonorrhœa, is that which attributes the production of the disease to the combined influences of neglect of personal cleanliness and hygienic precautions on the part of both the woman and the man, together with sexual and possibly alcoholic intemperance.

Fournier has shown that of 387 women known to have been the source of gonorrhœal infection, only 56 were prostitutes, the other 331 being made up of married women, kept women, shop girls, and domestics, or, in other words, of women with whom illicit intercourse was often of necessity clandestine, hurried, or performed under circumstances which did not admit of thorough ablution. Such women are of course more apt to be the subjects of uterine or vaginal catarrh, the secretions from which, if

¹ Pathology and Treatment of Gonorrhœa, p. 6.

retained as a consequence of neglect, are much more likely to be purulent and contagious than in women who live a regular and well-ordered life, and who are careful about their personal condition.

If these factors be duly considered, the escape of married men, the infection of "lovers," the comparative harmlessness of prostitutes (who learn to attend to cleanliness as a matter of business), and the great frequency with which the disease is contracted from certain classes of women, all become comprehensible, and may be said, in *résumé*, to depend upon the generally admitted facts, that in the female a purely mucoid discharge, or one with but slight purulent admixture, is contagious only to a very moderate extent;¹ that regularity in the performance of the sexual functions, absence of excesses of all sorts, and attention to personal cleanliness—circumstances usually existing in married life—tend to preserve the non-purulent character of such discharges; and that these conditions are usually reversed when intercourse is illicit, and particularly when it takes place with women who do not practise it as a profession. Consequently, we are not compelled to depend upon "acclimation" as the sole explanation of the immunity of married men, while at the same time we may maintain the original proposition, that gonorrhœa may be contracted from all forms of uterine and vaginal discharges.

The importance of having well-grounded and clearly defined views upon this subject, becomes evident upon reflection. If we assert or believe in our ability to recognize by certain symptoms a specific gonorrhœa, which could only have been obtained, except in instances so rare that they might practically be excluded, by contact or intercourse with an individual of the opposite sex having the same disease, we shall frequently be compelled either to prevaricate or actually to falsify, or else in many cases to put an end to domestic happiness or cause infinite misery and suffering. If a man with all the symptoms, presently to be detailed, of a typical case of gonorrhœa, asks the point-blank question as to the cause of his disease, and if, true to the "virulent" theory, and careless or ignorant of his sexual or matrimonial relations, we reply that it has almost certainly resulted from a similar discharge produced in its turn by a similar cause, we may possibly—indeed, taking the average of a large number of cases among the better classes, it is safe to say we will probably—do some innocent woman a great injustice, and, as in one instance of which I am personally cognizant, may even indirectly cause her ruin and death. It is never safe or proper to say that a given urethritis, vaginitis, or vulvitis, has resulted from impure sexual intercourse, although we may admit that the latter is the most *frequent* cause of these diseases.

There is a marked difference between the sexes as regards susceptibility and exposure to contagion, which we should remember for our own instruction, observing, however, the same caution as to expression of opinion. A man with a urethritis may have derived it from any one of the sources which have been mentioned, the woman, if it follow sexual intercourse, having been quite free from any truly venereal disease. In the majority of cases in which I have been asked to examine women suspected under these circumstances, I have failed to find any evidence of gonorrhœa in any of its forms. On the other hand, in the absence of traumatic or mechanical irritation, if a woman develops gonorrhœa—that is, a vulvitis, vaginitis, or urethritis—it is strong presumptive evidence that she has been exposed to contact with the secretion from a similar inflammation affecting the male urethra. The possible infecting or exciting causes of gonorrhœa in women are obviously much fewer

¹ Mr. Milton's rule, already quoted, that "even a slight amount of gonorrhœa is more likely to excite the same disease in another person than a pretty high degree of leucorrhœa is to bring on even simple urethritis," is a statement of this same fact, possibly a little exaggerated.

than in men, as the genital and urinary apparatus in the male is neither so extensive in surface nor so subdivided functionally as in the female, and her chances for contact with morbid secretions, other than that from a purulent urethritis, are correspondingly limited.¹ [See page 299.]

VARIETIES OF GONORRHOEA.

Gonorrhœa may then be defined as an inflammation of the urethra in the male, of the vagina, vulva, or urethra in the female, depending upon some local irritation for its development, the most common cause being contact during sexual intercourse with purulent or disordered secretions from the genito-urinary tract. In practice we meet with three distinct varieties of the disease, which are of definite clinical importance, and which may be described as:—

- I. Typical or acute inflammatory gonorrhœa;
- II. Subacute or catarrhal gonorrhœa;
- III. Irritative or “abortive” gonorrhœa.²

Distinctions based upon minor variations in the form or seat of the inflammation have been made, chiefly by those observers who have employed that very unsatisfactory instrument, the urethral endoscope. They have thus described a *membranous* urethritis with inflammation of the dorsal lymphatics of the penis; a *granular* urethritis, with numerous punctiform elevations of the mucous membrane; a *suppurative* urethritis, with the formation of abscesses in the submucous connective tissue; and an *ulcerative* urethritis, noticed in persons predisposed to herpes. I have never been able to distinguish these different forms with any degree of accuracy except when they have given rise to well-marked symptoms, such as follicular or peri-urethral abscess in the “suppurative” form, hemorrhage after urination in the “ulcerative” variety, etc.³ For practical purposes they may safely be ignored, and the division or classification above suggested may be adhered to.

¹ At intervals of a few years the doctrine of the dependence of gonorrhœa upon the presence and growth in the urethra of vegetable organisms—bacteria and micrococci—is revived and discussed. Neisser, Salisbury, Bokai, and lately Mr. Cheyne, Assistant Surgeon to King's College Hospital, have claimed to base their diagnosis and treatment of the disease upon the existence of these organisms. As their observations have never been confirmed, except as to the discovery of micrococci such as are found in pus under all circumstances, and whencesoever derived, and as the antiseptic plan of treatment is usually a conspicuous failure in cases of gonorrhœa, it will not be necessary further to allude to these theories. [See page 299.]

² Lebert classes the two latter forms together under the name of “slight, superficial, sero-purulent and mucous gonorrhœo-catarrh.”

³ J. Grünfeld (*Cbl. f. Chir.*, 1878, No. 21; from *Wiener med. Jahrb.*), as a result of his experience with the endoscope, describes the following forms of urethritis, which closely resemble those above given: (1) *Urethritis blennorrhœica*, acute blennorrhœa of the urethra without complication. The field of vision of the endoscope is filled with greenish pus, the mucous membrane underneath markedly reddened, greatly puffed out, and showing erosions here and there. The so-called lacunæ of the mucous canal are wanting, or their depth is reduced to a minimum. (2) *Urethritis membranacea*, characterized by striated layers of grayish-white membrane, the removal of which gives rise to slight bleeding. This form of disease is ordinarily complicated by inflammation of the dorsal lymphatics of the penis. (3) *Urethritis simplex*, a less marked variety of *U. blennorrhœica*, the mucous membrane being somewhat red and swollen, with injected blood-vessels; the lacunæ decidedly evident. (4) *Urethritis granulosa*. The mucous membrane is evenly colored; no isolated bloodvessels can be seen; wrinkles are for the most part wanting, but numerous punctiform elevations can be perceived, which are distinguished by reflecting light from their surface. (5) *Urethritis with the formation of abscesses*, which occasionally originate in herpes blebs, occasionally are chancreous sores, and sometimes proceed from badly treated strictures.

A form of gonorrhœa known as “gonorrhœa sicca,” or “dry gonorrhœa,” and unattended with discharge, is discussed by some authors. I have never seen a case of this disease, and am disposed to agree with Van Buren and Keyes, who attribute the symptoms—pain, ardor urinæ,

ACUTE INFLAMMATORY GONORRHOEA OF MALE URETHRA.

Taking up the subject of gonorrhœa in the male, we may begin with a description of the acute inflammatory variety, which is the one most frequently encountered, particularly in those persons who are for the first time affected.

The interval which elapses between exposure to irritation and the development of noticeable urethral symptoms, is a variable one, extending from a few hours to twelve or fourteen days. In the great majority of cases, however, the disease appears during the first week, and intelligent or observant patients usually discover indications of its presence within two or three days. Such persons will often tell you that they have experienced an obtrusive consciousness of the possession of a penis, an involuntary turning of the thoughts in that direction, a disposition to search or examine the organ, although no pain is felt, and no discharge can be seen. In a short time, however, one or the other of these symptoms makes its appearance, or they occur simultaneously. The patient notices a drop of milk-and-watery fluid at the meatus, which is slightly red and puffed or everted; a tickling sensation is often felt in this locality, and the next act of urination is attended with a feeling of warmth at the end of the canal, or with actual scalding. After this, the symptoms increase rapidly in number and severity, so that within forty-eight hours, or even sooner, the disease may be described as having gotten well into its first or "increasing" stage, the characteristic phenomena of which, with their respective causes, may be enumerated as follows:—

SYMPTOMS OF FIRST OR INCREASING STAGE OF GONORRHOEA.

CHANGES IN MEATUS.—There are *redness*, *eversion*, and often *erosion* of the lips of the meatus; sometimes, but rarely, so much swelling as to constitute a distinct obstacle to the passage of the urine, which escapes only by drops.

ARDOR URINÆ.—*Scalding* at each act of urination, or *ardor urinæ*, is the symptom which gives the disease in French its popular name of *chaude-pisse*. This is due partly to the distension of the inflamed and swollen mucous folds of the urethra during the passage of the stream, but chiefly to the contact with the inflamed surface of the salts of the urine. That this latter is the principal cause, is shown by the favorable influence which diluent and alkaline diuretics have over this symptom, although they actually increase the size of the stream, and consequently the amount of distension.

CHORDEE.—Painful erection, or *chordee*, is present to a greater or less extent in all such cases. It may occur at any time during the twenty-four hours, but is most frequent after the patient has become warm in bed. He is awakened or kept awake by an intractable, persistent priapism, which is associated with pain felt along the under surface, or often along the sides of the penis. In well-marked cases the organ is bent or curved, usually in a downward direction, more rarely upward or laterally. The corpus spongiosum, situated beneath and between the corpora cavernosa and surrounding the

etc.—to urethral neuralgia, and assert that the malady is not in any sense a gonorrhœa. Jullien thinks, however, that it is not illogical to consider the mucous membrane of the urethra as affected, in such cases, by an inflammation analogous to that of cutaneous erysipelas, the products of which in "blennorrhagie sèche" may be so slight as only to be detected by a careful examination of the urine. (*Maladies Vénériennes*, p. 35.)

urethra, is more directly involved in the inflammatory process than the other portions of the penis. The urethritis is not confined solely to the mucous layer of the canal, but extends by contiguity to the submucous connective tissue, and thence continuously to the trabeculae of the erectile tissue of the spongy body. The lymph, which is exuded in these localities, blocks or fills up the inter-trabecular spaces or meshes containing the intricate venous plexus which, by its engorgement and distension, furnishes the essential mechanical element of normal erection. When, either in response to sexual desire, or as a result of the local irritation of the urethritis, or induced by the contact of accumulated urine with the neck of the bladder, or suddenly occasioned by spasm of the muscles controlling the return of blood from the penis, the organ becomes erect, the corpora cavernosa expand normally and fully, but the blood is unable to find its way into the partially obliterated erectile tissue of the corpus spongiosum, which remains rigid and inflexible. The pain along the sides is produced by the pressure on nerves caused by the unnatural position, and that along the under surface by the attempted distension of the inflamed tissue of the spongy body. There is an analogous condition, consisting of a chronic circumscribed inflammation of the corpora cavernosa, in which erections are equally painful, but in which the curve is upward; or, if only one cavernous body is involved, the bend is lateral, and toward the affected side.

One explanation of the mechanism of chordee attributes the bending of the penis to spasm of the layer of longitudinal muscular fibres said partially to encircle the urethra.¹ These, however, are very scanty, are sometimes almost entirely absent, and have no normal functional activity. It is hardly conceivable that, even under persistent irritation, they should exert sufficient force to produce the severe and often long-continued bending of the penis found in chordee. Then, too, the characteristic pain in erection is frequently experienced without the least curving of the organ.

According to Hilton,² when the erection occurs suddenly, the cause is spasm of the muscles which control the blood supply to the penis, the spasm being due to irritation of branches of the pudic nerve, which are distributed to the inflamed mucous membrane of the urethra. The sudden and severe erections which occur during sleep are attributed by the same author to excito-motor action roused in the spinal cord when it is deprived of the control of the brain. Mr. Hilton also suggests that the greater distension of one side of the penis than of the other, which often occurs, may depend upon a greater amount of irritation on the corresponding side of the urethra. The variety of chordee which is produced by the effusion of inflammatory products into the corpus spongiosum, is considered by him to be quite distinct from the preceding forms.³ This explanation seems as far removed from the truth as that of Mr. Milton, mentioned above. At least, I have never seen any cases which could be distinguished as being due to muscular action. Doubtless erection is prolonged by the tendency of the erectors and compressors to spasm, but that this is in any sense the cause of either the pain or the deformity of chordee cannot, I think, be admitted.

FREQUENT URINATION WITH VESICAL TENESMUS is another symptom which occurs about this time in many cases. It generally indicates an extension of the inflammation to the deep urethra, but may exceptionally be due to reflex influence from a disturbance as yet localized at or near the meatus. In either event, the irritability of the neck of the bladder is shown by the inability of that organ to retain more than very small quantities of urine, and by the urgency of the calls to evacuate it, the difficulty in starting the stream, and the bear-

¹ Milton, *op. cit.*, p. 184.

² Lectures on Rest and Pain, 2d ed., p. 255.

³ Hill and Cooper, *Venereal Diseases*, p. 497.



1. Acute gonorrhoea with partial phimosis. 2. Balano-posthitis with herpetiform ulceration. 3. Paraphimosis with consequent ulceration. 4. Gonorrhoea in woman.



ing-down, expulsive efforts which accompany or follow the dribbling of the last few drops.

The *discharge* during this period has been growing more and more profuse. At first thin, and of a bluish-white hue—like city milk—it has become white, then yellow, and then greenish or streaked with blood-stains. If actual ulceration has occurred, it may contain a considerable admixture of blood, a few drops of which will follow each urination, produced by the rupture of minute capillaries during the contraction of the circular muscular fibres which takes place at the end of that act.

We have, then, certain conditions—ardor urinæ, profuse purulent discharge, chordee, and frequent urination—which characterize the increasing stage of inflammatory gonorrhœa, and all of which occur with so much frequency that they should be regarded as symptoms of that stage, and not classed, as is sometimes done in the case of the two latter, with the complications. Under this head, however, and observed during the same period, some annoying and troublesome results of inflammatory action may be described.

COMPLICATIONS OF FIRST STAGE.

BALANITIS.—When the inflammation, instead of remaining within the urethra or involving only the lips of the meatus, extends over the surface of the glans penis, we have the condition known as *balanitis*. This is usually caused by a neglect of cleanliness, the urethral discharge being permitted to remain in contact with the head of the penis, or allowed to accumulate under the foreskin, but it occasionally occurs, as has been said, from a simple extension of inflammatory action by continuity, and in spite of the greatest care. As in the case of gonorrhœa itself, some patients seem to be peculiarly subject to the development of this form of inflammatory action, and it has been noted that persons who have been troubled with erythema intertrigo are usually sufferers from this complication. In dispensary and hospital practice it is seen in about one-fourth of all cases, in private practice not nearly so often. The susceptibility to irritation of the mucous membrane of the glans is, for obvious reasons, much less than that of the urethra. Pus which would instantly excite an active urethritis, may often be permitted with impunity to bathe this region; astringents, such as nitrate of silver, which, when injected *per urethram*, give exquisite pain, have little or no effect on the thicker epithelium of this part, which, in circumcised persons or those with short or retracted foreskins, closely resembles epidermis in density and insensitiveness. If it were not so, the most scrupulous cleanliness would not prevent the large majority of patients with the variety of gonorrhœa under consideration from having this complication.

Symptoms and Diagnosis of Balanitis.—Its symptoms are those of superficial inflammation, heat, redness, burning or itching, and finally exfoliation of epithelium, leaving an eroded or sometimes a superficially ulcerated surface. Not infrequently little crops of herpetic vesicles (see Plate XV. Fig. 2) appear, and may remain discrete until they desiccate, or they may pustulate, coalesce, and leave an ulcer which is sometimes mistaken for a chancre or chaneroid.

Between the balanitic ulcer and the chaneroid, the differences seem to me chiefly those of degree, a more intensely irritating or corrosive pus causing deeper and more intractable ulceration. Indeed, I have on more than one occasion seen balanitic ulcers subsequently removed from treatment by the

occurrence of phimosis, and at a still later period disclosed by operation, in which all the so-called specific characters of the chancreoid—the abrupt or undermined edges, the tendency to spread, the profuse discharge, etc.—were present. The diagnosis here is of no great importance, as treatment should be applied in either event on the same principles. Mild local measures suffice in both cases to cure the majority of sores; in those which continue to extend or which remain intractable, cauterization with nitric acid is indicated both theoretically and empirically.

The form of the initial lesion of syphilis known as the *chancreous erosion*, may be mistaken for a superficial balanitis. The period of incubation, the absence of urethral discharge, the abrupt limitation of the erosion, the presence at its base of “parchment” induration, the enlargement of the inguinal lymphatics, and the lack of inflammatory element, are symptoms of the former condition which should render it easily distinguishable from a solution of continuity due to balanitis.

BALANO-POSTHITIS.—An extension of the inflammation from the surface of the glans to the inner or mucous layer of the prepuce gives rise to what is known as *balano-posthitis*, which has no special clinical significance, except that it is almost invariably followed by, or associated with, an inability to retract the foreskin, so as to uncover the glans penis.

This is due to an extension of the inflammation to the loose cellular tissue uniting the two surfaces of the foreskin, which rapidly becomes œdematous, and in some cases is the seat of an effusion of plastic lymph.

PHIMOSIS.—The *phimosis* thus produced is an extremely objectionable complication, as it interferes with treatment, necessitates most vigilant and unremitting care as to cleanliness, and obscures diagnosis and prognosis. If the case has not been watched from the beginning, and the patient comes under observation for the first time with a vague history and with an œdematous, swollen prepuce (see Plate XV. Fig. 1), from the orifice of which pus or pus and blood exude, it is not always easy to determine the exact underlying condition. An indurated chancre can generally be discovered without trouble by its hardness, and is moreover not often complicated in this manner. A soft or chancroidal sore, however, or a balanitic ulceration, may not be so readily recognized. The main points of distinction may be tabulated as follows:—

PHIMOSIS FROM GONORRHOEA.

No history of sore on glans or prepuce.
Swelling in foreskin at first almost entirely œdematous.
Discharge usually purulent.
No definite area more tender or harder than the rest.
Chordee often present.
Ardor urinæ extends along whole length of canal.

Vesical symptoms not infrequent.

Bubo very rare.

PHIMOSIS WITH SUB-PREPUTIAL CHANCROID.

History of sore.
Swelling often due to presence of plastic lymph around ulcer.
Discharge often sanguinolent.
A distinct spot usually discoverable by palpation.
Never any true chordee.
Ardor urinæ only when the urine comes in contact with the inflamed or ulcerated foreskin.

No vesical symptoms in uncomplicated cases.

Bubo common.

It is not at all uncommon for patients who have had no experience in venereal disease to assume that a balanitis originating in uncleanness, and

due to the retention and decomposition of smegma, is a gonorrhœa. In dispensary practice, such patients are usually seen after having passed through the hands of an apothecary who, prescribing, as is usual with such persons, without making an examination, has administered a course of copaiba, sulphate of zinc, etc., in place of the soap and water which were all that was requisite. Of course no such mistake can be made by a careful practitioner; but even he may be temporarily in doubt when the balanitis is complicated with a phimosis so tight as to prevent any view of the meatus. In these cases, however, subpreputial injections are the first essential of treatment in any case, and will soon allay the swelling, so as to permit of sufficient retraction of the prepuce to resolve all uncertainty.

PARAPHIMOSIS, a condition in which the prepuce, retracted and caught behind the projecting corona glandis, cannot be brought forward, is a less frequent but more annoying and dangerous complication. The tense and rather inelastic edge of the preputial orifice constitutes the cause of the constriction, which grows tighter and tighter as swelling increases. The neighboring parts, at first œdematous, soon become infiltrated with inflammatory lymph, the return of blood from the glans is interfered with, and, in extreme cases, ulceration or even extensive sloughing of the head of the penis has occurred, and would doubtless be more frequent were it not for the extraordinary blood supply of the glans, and the anastomosis between its vessels and those of the corpora cavernosa. The line of constriction (see Plate XV. Fig. 3) is situated a short distance behind the glans, *immediately* back of which is a furrow due to the normal depression existing there, intensified by the surrounding œdema. Back of this is a swollen fold of mucous membrane, which is the part of the inner layer of the prepuce, normally in contact with the posterior face and edge of the corona. Then is found a second and very deep furrow, which is the actual seat of the trouble, and behind this another prominent collar of swollen integument. It is attended with severe, sometimes excruciating pain, which does not disappear until either the prepuce has been replaced, or the constriction has been relieved by division or by ulceration. It is often productive of deformity from cicatricial contraction in those cases in which surgical interference has been delayed or ineffective.

These complications—balanitis, balano-posthitis, phimosis, and paraphimosis—are by far the most frequent which make their appearance during this early period of the disease, and have accordingly been described in their usual clinical order. The first stage, or that in which there is a progressive increase in the severity of the symptoms, is of variable duration, but under well-directed treatment commonly terminates in from five days to a week, after which, for a short time, the condition appears to remain stationary.

SYMPTOMS AND COMPLICATIONS OF SECOND OR STATIONARY STAGE.

The discharge is still profuse, and the ardor urinæ and chordee marked, and in some cases agonizing. Patients will complain bitterly that their comfort during the day is interfered with by urgent calls to urinate, which they resist to the last possible moment, in a vain endeavor to avoid the pain occasioned by it; and that their rest at night is disturbed by frequently recurring erections, which are no less painful, and which often will not subside until some means be adopted for their reduction. During this period, which may be said to extend on an average from the seventh or eighth day to the

end of the second week, the inflammation is gradually extending backward, and may give rise to other complications.

FOLLICULAR AND PERI-URETHRAL ABSCESSSES.—Dipping down from the urethral membrane into the little mucous follicles which empty upon its surface, the inflammation of gonorrhœa occludes their mouths by causing swelling of their lining membrane, and converts them into little bags or pockets of pus—*follicular abscesses*—which appear as small, round, tender tumors along the under surface of the urethra. They very often open internally, but now and then adhesion to the skin takes place, pointing occurs outwardly, and they discharge upon the cutaneous surface. Fortunately they are not followed by urinary fistulæ. If the suppurative process involves the loose connective tissue around the urethra, a *peri-urethral abscess* is formed. This is most frequent at precisely the points which on *a priori* grounds would have been selected—those at which gonorrhœa is most persistent, the fossa navicularis and the anterior part of the membranous urethra. It is accompanied with localized tenderness and swelling, but on account of the easily distensible nature of the structure in which it is situated, is not very painful. It is a more dangerous complication than the folliculitis, just described, as in rare instances its spontaneous evacuation into the urethra has permitted of extravasation of urine with all its attendant dangers. It is also much more apt to be followed by persistent fistulæ. I have now under my care several cases in which pin-point communication exists between the urethra and the external surface, in the neighborhood of the frænum and near the peno-scrotal junction.

LYMPHANGEITIS.—In a certain proportion of cases of gonorrhœa, a simple *lymphangeitis* occurs as a result of absorption of purulent matter. It affects most commonly the lymphatics of the dorsum of the penis, and has been in my experience almost invariably associated with neglect of cleanliness and retention of the discharge between the prepuce and the glans. This is what might be expected on anatomical grounds from the group of lymphatics involved, those directly connected with the urethra itself belonging to the deeper set, and running beneath the pubic arch to join the deep lymphatics of the pelvis, and to terminate in the lumbar glands.

The *symptoms* consist in a thickened, cord-like line of induration, extending from the prepuce to the root of the penis, usually tender to the touch, easily isolated from the surrounding structures, and often traceable upon the surface by a faint red linear blush. The *dorsal phlebitis* which is said sometimes to occur, is described as associated with more cedematous swelling, and is said to be without the distinct line of induration separable from adjoining parts, and to be unassociated with any enlargement of the lymphatic glands of the groin, which is rarely absent when the lymphatics are involved. I have never seen a case of this character, and believe it to be an exceedingly rare complication of gonorrhœa. The lymphitis of syphilis is unassociated with tenderness, has for its point of origin the initial lesion, and is accompanied by multiple painless indurations of inguinal glands.

BUBO.—Either with or without this condition as a forerunner, adenitis of one of the glands of the groin may be the result of gonorrhœa—or, in other words, we may have a gonorrhœal *bubo*. The gland affected is usually one of the superficial set, lying just below Poupart's ligament, imbedded in the subcutaneous cellular tissue, and above the fascia lata. A small, painful tumor makes its appearance in the groin; it is at first freely movable beneath the skin, but afterwards contracts adhesions to the latter and to the surrounding parts, becomes doughy in feel, and reddish or purplish in hue. In the

majority of cases, after reaching this condition, it will subside under appropriate treatment, disappearing by resolution. In others, however, particularly in individuals of scrofulous tendencies, or in those broken down by vicious habits or by overwork, suppuration ensues, the connective tissue which surrounds the gland liquefying first. Indeed, very often the glandular structure itself is not involved in the suppurative action.

Another group of complications may be mentioned as possible occurrences towards the end of the third week, some of them, however, often appearing much later. They are Cowperitis, Prostatitis, and Cystitis.

COWPERITIS.—Inflammation of one or both of Cowper's glands, or *Cowperitis*, is a result of extension of the urethritis by continuity along their ducts, which empty into the posterior portion of the spongy urethra—that part incorrectly described as the “bulbous” portion. The first symptom usually developed is pain in the perineum, much increased by pressure, and rendering sitting or walking markedly painful. The inflammatory swelling of the glands is resisted by the two layers of the triangular ligament between which they are situated, and by the deep perineal fascia, and this resistance, associated with the determination of blood to the part by gravitation, imparts, as in other inflammations where the same conditions exist, a throbbing element to the pain, which renders it peculiarly distressing. The glands may often be felt as two small hard tumors, situated just back of the scrotum, one on either side of the median line; or may be recognized by pressure made in an upward and forward direction by the finger inserted just within the external sphincter. Urination is difficult if the swelling be great, and is always painful, particularly at its termination, as the glands are surrounded by the transverse fibres of the compressor urethræ muscle—which, contracting to expel the last drops of urine, compresses their inflamed and tender structure. Suppuration in the peri-glandular tissue sometimes occurs, in which case the usual signs of the formation of pus are present.

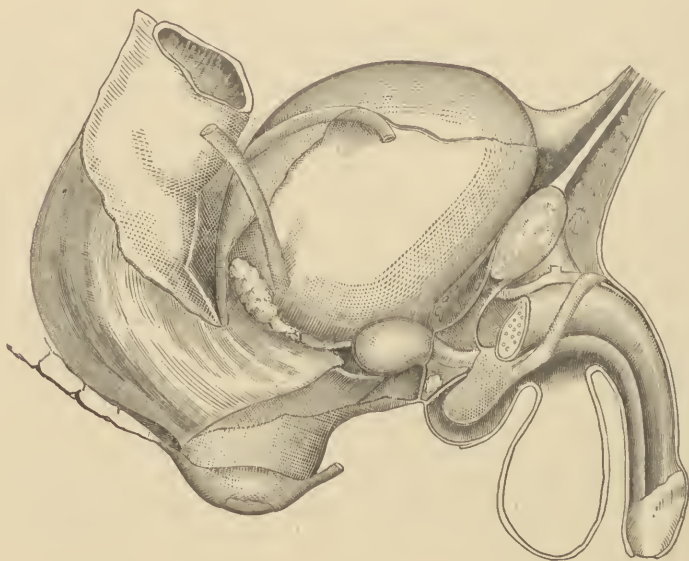
PROSTATITIS.—After gonorrhœa has crept or spread backward as far as the prostatic urethra, it may, and in some cases unavoidably does, in spite of the best directed treatment, involve the *prostate gland*. The follicles and the glandular element of this body are primarily and chiefly affected, the muscular tissue which composes the larger portion of its mass remaining in moderate cases uninvaded.

Harrison, in a paper on acute prostatitis, read at the Medical Society of London, April 11, 1881, divides this affection into two varieties, follicular prostatitis and general or parenchymatous prostatitis, the former attacking the glandular structure, but remaining limited to it, and attended with the symptoms above described; the other more rare, much more serious, and developing as if the whole gland within the capsule were at once involved in the inflammatory action. Suppuration usually supervenes, and unless treatment is prompt and decisive, on the first appearance of fluctuation as revealed by rectal examination, the most serious results both as to structure and life are likely to follow. The persons in whom this variety is said by Mr. Harrison to occur most frequently, are those of deteriorated constitutions, or with urinary organs more or less damaged by long-standing obstructive disease.

The anatomical and physiological relations of the gland (see Fig. 317) furnish at once a key to the symptoms produced by its inflammation, the earliest of which will probably be a feeling of weight and distension in the perineum and rectum. This is soon followed by frequent urination, due to the inability of the bladder completely to empty itself, the exit of the urine being interfered with by the engorged gland. The end of the act is painful, but is not

accompanied with the degree of tenesmus which is noticed when the bladder itself is involved, nor with any marked discharge of pus and blood. Defecation also is painful, markedly so if the feces are inspissated, and the finger inserted into the rectum feels the anterior wall pushed into the centre of the bowel, hot, unnaturally firm, and tender to the touch, while through it the indefinite outlines of the greatly enlarged prostate can be felt.

Fig. 317.



Relations of the prostate to the neck of the bladder and the rectum.

As the disease progresses the pain increases, becomes throbbing, particularly when the patient is erect or in the sitting posture, radiates along the cords of the hypogastric plexus to all the neighboring regions, and is very greatly aggravated by any evacuation of the bladder or rectum. The frequency and difficulty of micturition both increase, the latter sometimes proceeding to complete retention.

The disease may terminate by resolution, the most frequent way, or by suppuration. In the former event, the symptoms gradually subside, and the urethral discharge, which has been replaced during this period by the albuminoid secretion of the prostate, reappears and is often profuse. If suppuration occurs, it is usually due to the coalescence of several inflamed follicles, which, lying in proximity to one another, have broken down into a common cavity. The pus is frequently discharged into the urethra, but occasionally pointing takes place in the direction of the rectum. In either event, evacuation gives great relief.

In most cases, the prostate is left with some fibrous thickening—a hyperplasia of its cellular tissue—which is often the groundwork for future trouble, but which should not be confounded with the hypertrophy of the same tissue

and of the muscular elements, which so frequently takes place in advanced life.¹

An acute prostatitis may run into a chronic condition which is very annoying and intractable. The same symptoms exist in a modified and much subdued form; the pain is replaced by a sense of weight and fulness; micturition is rather too frequent, and is feeble, the last drops dribbling from the meatus; a mucoid discharge like the white of raw egg, but occasionally milky, may be squeezed from the urethra by deep pressure from behind forward, and the same discharge appears at the meatus after every evacuation of the rectum. By examination through the latter, the gland is found to be somewhat enlarged, and slightly tender on firm pressure.

As it is desirable in this as in some other cases, hereafter to be described, to ascertain the character of the discharge and also the exact locality of the inflammation which furnishes it, it may be well to have recourse to a bulbous bougie, it being remembered that in this condition the acute symptoms have subsided, and that there is but little danger of re-kindling the urethritis. The bougie, the head of which should be large enough comfortably to fill the urethra, should be passed down to the junction of the spongy and membranous portions, and then withdrawn. If it bring with it, as it probably will, some muco-pus from the anterior part of the urethra, this should be wiped off, and the instrument again inserted as far as the neck of the bladder. On removing it, a quantity of the prostatic secretion will usually be found upon the shoulder of the bulb. Pain is generally excited by the contact with the instrument, and the degree of sensitiveness will furnish a valuable indication for treatment, and should be carefully observed.

The mental symptoms associated with this trouble are often the most distressing. They will be alluded to again when we come to consider the sequelæ of gonorrhœa.

CYSTITIS.—A greater or less involvement of the neck of the bladder is often a concomitant of acute prostatitis, and is indicated by increased urinary trouble and by the appearance of a drop or two of blood at the end of micturition. This *prostatocystitis*, which is the form of bladder trouble usually encountered in gonorrhœa, may subside under treatment, or may pass into a well-developed inflammation of the mucous membrane of the vesical neck. In this case (*Gonorrhœal Cystitis*), we have certain well-marked symptoms, chief among which are very frequent urination, the patient not being able to retain his water for more than a few moments, and the desire to expel it becoming intense and irresistible on the slightest delay; excessive vesical tenesmus at the end of the act, which is characterized by severe burning pain instead of a sense of relief; blood and pus following the stream of urine, the latter part of which is turbid or milky. There are few constitutional symptoms, little or no fever, no rigors, and but slight deterioration of the general health unless the disease runs a protracted course. The diagnosis between prostatitis and cystitis, which are the only complications of gonorrhœa likely to be confounded, may be made by attention to the following points:—

¹ "Zeissl believes that in every case of chronic gonorrhœa there is moderate tumefaction of the prostate. Individuals who have very frequently had gonorrhœa, or in whom gonorrhœa has persisted for a long period, are said to be the subjects of a considerable enlargement of the prostate in their thirty-fifth year or even younger, the growth being due to the persistent hyperæmia of the part during the prolonged urethritis." Among 2041 cases of gonorrhœa admitted into the Antiquaille Hospital of Lyons, under the care of Dron, prostatitis occurred only three times. (Hill and Cooper, *op. cit.*, p. 530.) This is certainly an unusually small number, and in all probability must have been due to a failure to recognize the disease, or to its classification under some other name.

PROSTATITIS.

Not as frequent a complication of gonorrhœa as a mild form of cystitis.

Perineal and rectal pain.

Pain violent and throbbing, aggravated during defecation.

Pain not markedly severe at the end of urination.

Tenesmus not always present.

Stream of urine diminished in size.

Retention of urine common.

Urine not much changed in appearance.

Rectal examination shows enlargement and great tenderness of the prostate.

CYSTITIS.

Occurs in its lower grades in perhaps one-fourth of all cases of gonorrhœa.

Possibly a little tenderness of perineum on pressure, but no rectal pain.

Pain burning, not especially affected by defecation.

Much pain in passing the last drops of urine.

Tenesmus constant and severe; very characteristic.

Size of stream not always affected.

Retention of urine rare.

Urine turbid and ropy, last drops mixed with blood.

No prostatic enlargement or tenderness recognizable by rectal examination.

Two conditions are said by Mr. Reginald Harrison closely to simulate acute prostatitis, the first being inflammation and suppuration *around* the membranous portion of the urethra as a consequence of urethritis; and the second, inflammation and plugging of the veins constituting the prostatic plexus. The diagnosis between the former condition and prostatitis should be made chiefly by the situation of the swelling, which here will be perineal, while in inflammation of the prostate it is difficult to imagine how the tumefaction can invade the region of the perineum. It certainly does not become apparent there when the prostate is hypertrophied in old age. When suppuration occurs, the pus may be discharged by a perineal opening, when it arises from a peri-urethritis; it never is so in prostatitis.¹

The other disordered condition is said to be rare. Mr. Harrison, who has only seen two cases of it, describes the primary lesion as œdema of the prepuce dependent upon plugging of the dorsal vein of the penis. In both cases a feeling of perineal weight, frequent micturition, and uneasiness referred to the neck of the bladder, come on in a few days. Rectal examination is said to have determined that these symptoms were not due to any inflammation of the gland, but to the extension of the vein-blocking to the prostatic plexus.

I have never seen such cases, and do not believe that digital examination *per rectum* will disclose with any definiteness the condition of the veins said to be involved. On the other hand, a follicular prostatitis not extending to any depth from the urethra, will often give rise to no general tumefaction of the gland, and to little or no tenderness on rectal pressure, while at the same time it would produce all the above-mentioned symptoms. Probably autopsies alone can determine the existence or non-existence of this alleged prostatic phlebitis.

These complications belong in the majority of cases to the latter part of the *stationary* period of gonorrhœa, which extends over from one to two

¹ The points of similarity between the two conditions are very marked: "In both there is a cessation or alteration in the character of the urethral discharge; in both there is a feeling of weight and uneasiness about the perineum; in both there is some difficulty in micturition, perhaps amounting to retention; and in both there is some tumefaction to be felt, and much distress is occasioned on introducing the finger into the rectum. So painful is the latter to the patient that it often leads to an imperfect examination being made, and hence an error of diagnosis arises in exactly fixing the position of the tumefaction, which might have been avoided." (*Medical Times and Gazette*, July 2, 1881.)

weeks, rarely longer, and during which the acute symptoms of the first stage, the ardor urinae, chordee, etc., remain, as has been said, nearly or quite unaltered.

At the termination of this stage that of *subsidence* begins, and in uncomplicated cases progresses rapidly until complete recovery has taken place.

SYMPTOMS AND COMPLICATIONS OF THIRD STAGE, OR THAT OF SUBSIDENCE.

Urination becomes painless and less frequent; the discharge grows thinner, becomes watery and scanty, or dries up altogether; erections no longer occur with abnormal frequency, and do not give rise to curvation of the penis or to pain. If any of the complications which have been described has existed, the last vestiges of it fade away, and perfect health is restored.

But until this stage is actually completed, as long as any of the symptoms of urethritis are still evident, there are yet certain dangers to be avoided, and serious difficulties which may present themselves.

EPIDIDYMITIS.—Chief among these, in respect to frequency of occurrence, is *epididymitis*, or swelled testicle, which is a complication usually supervening in the fifth or sixth week of the disease, sometimes coming much earlier, and rarely as late as the end of the second month, or even in the third month. In the great majority of instances it is obviously the result of the extension of the urethral inflammation along the ejaculatory ducts and spermatic canal to the epididymis itself.¹ In others this connection between the original inflammation and the epididymitis is not apparent, and various theories have been adduced to explain the phenomenon.² The sympathy existing between the various portions of the genito-urinary system, metastasis, reflex nervous agency, and other hypotheses, are all unsatisfactory, and, as it seems to me, unnecessary. The absence of conclusive post-mortem or clinical proof that the vas deferens is the medium of transmission in almost every case is readily understood when we remember, on the one hand, that the deaths which occur during this stage are from intercurrent diseases, and are very rare, and, on the other hand, that it is not at all uncommon for inflammation to travel rapidly, leaving behind it no foot-prints, over extensive mucous surfaces.³

If the disease were metastatic in its origin, or the result of "sympathy" or of reflex irritation, it is difficult to see why it should stop at the epididymis, which is an excretory duct and a comparatively unessential part of the testicle, and should spare the secretory portion of that gland. The early symptoms usually indicate more or less clearly the course of the disease, and, indeed, the clinical evidence, and the period at which the affection develops

¹ M. Terrillon asserts (*Le Progrès Médical*, Jan. 29, 1881) that in swelled testicle the inflammation is principally in the cellular tissue around the epididymis, rather than in that organ itself.

² Dr. Otis, in a clinical lecture on epididymitis (*Boston Medical and Surgical Journal*, Nov. 28, 1878), after calling attention to its association with strictures of large calibre, adds: "Such strictures are capable of producing recurring epididymitis of every grade, from that which causes slight swelling and tenderness to the most acute form of the trouble. My own observation leads me to believe that the lighter forms of trouble, such as chronic sensitiveness and occasional slight swelling, also various grades of hydrocele, are the result of reflex irritation transmitted from a point of stricture, and that the attacks of acute epididymitis are due to the extension of the inflammation—the urethritis associated with stricture—along the track of the vas deferens, as in epididymitis accompanying ordinary gonorrhœa."

³ In 1871, MM. Gombault and Terrillon made an autopsy in the case of a young man, aged 19, who died of an intercurrent disease during an attack of gonorrhœa. They found the vas deferens, in its entire extent, filled with the products of catarrhal inflammation, red, swollen, and injected; no epididymitis had yet developed.

in the great majority of cases, when taken in conjunction with the evidence obtained by experiment, are quite sufficient to explain the production of the epididymitis in the manner indicated. The first symptom which attracts the attention of the patient is an aching, occasionally a neuralgic pain, along the line of the groin, more frequently on the left side.¹ If the cord be taken between the thumb and finger at this time and rolled gently so as to separate its constituents, the vas deferens will be found enlarged usually to but a slight degree, but sometimes to three or four times its normal diameter; it will also be tender on pressure.² Sometimes, but rarely, it will be insensitive, and in this event, in many cases, the inguinal pain will prove to be simply neuralgic in its character, and no further trouble will result. If the inflammation progresses, however, and the epididymis is involved, this preliminary pain is soon followed by a feeling of weight and a dull ache in the affected testicle, which begins to increase in size and rapidly becomes of great bulk, purplish in color, and exceedingly painful.³ (See Plate XVI. Fig. 1.) The nauseating quality possessed by this pain is peculiar to it, and serves greatly to aggravate its unpleasantness.

The patient, particularly if the testicle be not supported so that its weight is withdrawn from the cord, will walk in a slightly stooping posture, with the legs apart—a straddling, constrained attitude which is almost pathognomonic of this ailment. The dragging of the heavy tumor upon the spermatic vessels prevents the free return of blood from the testicle and serves to increase the tension, and by additional pressure upon the nerves to add to the pain, which in some instances spreads by reflex agency to the loins, abdomen,

¹ Jullien has collected 2158 cases of epididymitis, of which 1011 were on the right side, 982 on the left, and 165 double. (*Maladies Vénériennes*, p. 104.) "Of 1342 cases observed by Sigmond, of Vienna, the *left* testicle was affected in two-thirds." (Bumstead and Taylor, *Treatise on Venereal Diseases*, p. 133.)

² M. Terrillon (*Bull. de la Soc. de Chirurgie*, 1881, No. 2) details four different degrees of inflammation of the vas deferens observed when the disease is experimentally excited: (1) Mucous membrane alone attacked; (2) More frequently muscular walls also involved; (3) Cellular tissue of spermatic cord affected; (4) General connective tissue and scrotum inflamed. He thinks that the sole theory of epididymitis which is at all tenable is that which ascribes it to propagation of the inflammation along the ejaculatory ducts and the vas deferens.

³ In exceptional cases, a patient with gonorrhœa having a complete inguinal hernia, or having accidentally received a blow on the scrotum, may develop a painful tumor of the scrotum, about the diagnosis of which some difficulty will exist. The following table of Mr. Christopher Heath very well represents the differences between the gonorrhœal complication and the other diseases for which it may be mistaken:—

STRANGULATED HERNIA.	HÆMATOCELE.	ORCHITIS OR EPIDIDYMITIS.
Suddenly produced, or, if present before, suddenly strangulated;	Suddenly produced by some external violence;	Developed a few hours after a blow or following gonorrhœa;
Pain in groin and about abdomen, with considerable constitutional depression and anxiety of face;	Pain in scrotum and constitutional disturbance, slight after the first few minutes;	Pain in scrotum and along the cord to the loins; feverish disturbance of system;
Tumor tense, and giving the sensation of intestine when manipulated; skin normal;	Tumor tense and heavy, globular in shape, and not translucent; skin often bruised;	Tumor excessively tender to the touch; cord thickened; skin reddened;
Impulse on coughing to be felt along the groin, in which there is more fulness than usual, but ceases abruptly at the point of strangulation;	No impulse in groin, which is perfectly normal.	No impulse on coughing;
Percussion over tumor gives a clear sound unless the protrusion is omental;	Percussion gives a dull note;	Percussion gives a dull note;
Vomiting probably present, continuous, and eventually stercoraceous.	Vomiting immediately following the accident, but not continued.	Nausea and faintness, but seldom vomiting.





1. Epididymitis.

2.3. Gonorrhœal Conjunctivitis.

4. Vulvo-vaginal Abscess.

thighs, and even the thoracic region, and is almost unbearable. There are usually more or less febrile disturbance, and great mental anxiety and depression. Under proper treatment, the acute inflammatory symptoms subside by resolution in a few days, but the enlargement disappears very gradually, a small portion of the globus minor often remaining perceptibly indurated throughout life. In neglected cases, the testicle proper becomes involved, which may be known by an increase in the size and density of the tumor, by the uniform diffusion of the swelling, which can no longer be outlined at the back of the scrotum, by the unusual tenderness on pressure, and by the persistence of the pain, nausea, etc., in spite of such treatment as usually gives relief.¹

In a still smaller number of cases, suppuration occurs in the subcutaneous cellular tissue, and sometimes involves a large portion of the scrotum. These terminations of epididymitis result, as a rule, from improper treatment, or are found in the broken-down and intemperate subjects of hospital or dispensary practice. Of the numerous sequelæ said to follow swelled testicle, I have seen very few instances. A lingering tenderness in the region of the epididymis is quite common, but true neuralgia of the testicle, with its agonizing pain, must be very rare, as I have never met with a single instance of this condition to which epididymitis seemed to have any definite causative relation. It is unquestionable that persistent induration of the globus minor, which consists of a single tube for the passage of semen, may interfere with or entirely prevent the exercise of its function, and that if both testicles have been involved, sterility more or less permanent may result. There may be, however, and usually are, all the indications of virility; there is no diminution in desire, nor in ability to perform the sexual act, which is accompanied by emission of fluid derived chiefly from the prostate and the seminal vesicles, and which is attended by the customary amount of pleasure. In other words, the patient, though sterile by reason of the absence of spermatozoa from the fluid which he emits, is not by any means impotent. Time and suitable remedies will often remove this condition, at least to a degree which permits of the reappearance of small numbers of spermatozoa in the semen, and consequently restores to the patient his ability to beget children. The prognosis in this respect should be guarded.²

That the left testicle is affected twice as often as the right, is usually attributed to the fact that as a rule it hangs lower, and thus receives less support from the scrotum. It is more probably, however, the result of the position of the left spermatic vein behind the sigmoid flexure, where it is especially subject to obstruction by pressure, and also of its indirect communication with the vena cava through the renal vein, which it enters at a right angle, the right spermatic vein emptying into the cava at an acute angle. The left spermatic vein is also unprovided with a valve at the point of entrance into the renal vein. These causes are sufficient to produce local congestion, a powerful predisposing cause of inflammatory attacks. As a result of pressure on the efferent vessels by inflammatory products, or as a consequence of extension of the inflammatory action itself, *acute hydrocele* may and often does complicate epididymitis, adding to the size of the swollen

¹ Sigmund (quoted by Hill) found that, in 1342 cases, the epididymis was alone affected in 61; the epididymis and cord in 108; the epididymis and tunica vaginalis in 856; and all three parts in 317. Of Dron's 726 cases, the body of the testis was affected in only ten; and of Hardy's 226 cases, the inflammation attacked the testis proper in but nine.

² Gosselin, Curling, Liégeois, Godard and Terrillon, Hill, Bumstead, Lebert, and others all coincide in the belief that double epididymitis is, in the great majority of cases, followed by sterility, or the absence of spermatozoa from the semen, and that there is very little probability of entire recovery. In 117 cases of this character, which I have been able to collect from various sources, only thirteen were recorded as experiencing any improvement from treatment.

organ and increasing the feeling of tension to both the patient and the surgeon. It requires no special treatment, and usually subsides when the declining stage is reached.

PYÆMIA, as a sequence of gonorrhœa,¹ and PELVIC CELLULITIS, following the extravasation of urine resulting from the rupture of a gonorrhœal periurethral abscess, are possible accidents, and in spite of their extreme rarity should be borne in mind in the management of these cases. PERITONITIS is also, as might be supposed, of very exceptional occurrence. I have seen this complication in one case, of which the following is a brief *résumé* taken from my case book:—

R. K., aged 23, suffering with his first attack of gonorrhœa, was in the second week of the disease and progressing favorably when he suddenly felt pain in the groin and along the track of the cord, which led me to believe that he was about to develop an epididymitis. Instead, however, of the testicle swelling, the pain and tenderness spread from the right groin over the surface of the abdomen, which soon became tense, almost tympanitic, and sensitive to the touch. From this time onward he manifested all the symptoms of acute peritonitis, which for some days endangered his life, and which required the usual treatment. Dr. H. C. Wood saw him with me at this time. During the subsidence of the peritonitis, a low grade of epididymitis occurred. The most interesting point about the case was the discovery that the patient had previously had a small congenital hydrocele which, as it could be returned into the abdomen, had at one time evidently been carelessly mistaken for a hernia, a truss having been applied by order of a physician. This explained very clearly the etiology of the case, the communication between the peritoneal cavity and the tunica vaginalis, through the funicular process, being uninterrupted, and permitting of a ready extension of the inflammation from the vas deferens, through the surrounding cellular tissue, to the peritoneum. Some weeks after complete restoration to health, no trace of the affection was discernible.²

The foregoing complications are chiefly, although not exclusively, met with in gonorrhœas of the first or acute inflammatory variety.

We may now consider that form of gonorrhœa which has been designated as *subacute* or *catarrhal*.

SUBACUTE OR CATARRHAL GONORRHOEA.

This occurs most commonly in persons who have had previous attacks of gonorrhœa, and is an example of the tendency manifested by all mucous structures to take on inflammation upon slight provocation after having once been affected. It is particularly noticeable in the urethra for several reasons: the canal affords periodical passage to a secretion, the urine, which is especially liable, by reason of changes in its constitution, to become an actual irritant; it is exposed, at times of erection, to intense congestion of all its vessels, and the converse is also true, a congested or irritated spot along the

¹ Hill and Cooper quote (op. cit. p. 546) three fatal cases of pyæmia, in all of which there was phlebitis of the prostatic plexus. In all of them also the urethral mucous membrane was intact. Agnew reports a fatal case (Principles and Practice of Surgery, vol. ii. p. 468) occurring in an exceptionally robust man.

² A few cases are recorded in which peritonitis occurred as a complication of epididymitis. In the majority of them, however, the connection between the two diseases is not satisfactorily demonstrated. Dolbeau and Terrillon have each reported a case in which fatal peritonitis followed gonorrhœal epididymitis affecting an undescended testicle. MM. Godard, Peter and Gosselin have published cases in which the spread of the inflammation along the spermatic cord to the abdomen, and thus to the peritoneum, was demonstrated by post-mortem examination.

urethra predisposing to erection; gravitation, the proportionately excessive supply of blood to the region, and the absence of extra-vascular resistance due to the loose character of the spongy tissue, all favor the persistence of any vascular enlargement or congestion left after a first attack of urethritis; the condition of approximation of the mucous surfaces, as of the urethral walls during the intervals of micturition, is here as elsewhere unfavorable to the disappearance of granular or injected areas, or other traces of inflammation. For these and other reasons, among the immense number of young men who have had gonorrhœa once, comparatively few escape subsequent manifestations, a predisposing cause being usually present, although some additional irritant such as contact with menstrual fluid, or with a leucorrhœal secretion, is generally necessary to bring on marked symptoms.

A patient with this variety of urethritis will present himself to the surgeon at a variable time after a suspicious or an unaccustomed connection, with a free, muco-purulent or purulent, urethral discharge. He will complain of very little pain, possibly only of a sensation of warmth during urination, or there may not be the least alteration of sensibility. Chordee is absent or very slight, there is no vesical irritability, and the complications which have been detailed are exceedingly infrequent. The only affection for which this form of gonorrhœa is likely to be mistaken is urethral chancre, the possibility of which should never be forgotten.

The diagnosis between infecting chancre of the urethra and gonorrhœa may be made by attention to the following points:—

URETHRAL CHANCRE.

Symptoms appear after a period of incubation rarely less than ten days, often two or three weeks.

Confined to meatus or its immediate neighborhood.

Ardor urinæ felt only at lips; no chordee.

Discharge moderate, never purulent, often bloody.

Induration perceptible to touch, usually involving only one lip of meatus.

Invariable enlargement of chain of inguinal lymphatics, which are painless and freely movable, and almost never suppurate.

Sore can almost always be seen as a loss of continuity of mucous membrane.

Constitutional symptoms follow after from six to eight weeks.

Use of syringe painful at meatus.

URETHRITIS.

Symptoms follow suspicious intercourse in from twenty-four hours to a week, rarely at a longer interval.

Begin at meatus but extend some distance backward.

Ardor urinæ felt along the urethra; chordee often present.

Discharge more profuse, decidedly purulent,¹ not so often or so largely stained with blood.

No induration.

If lymphatics are involved at all, only one is affected, which often goes on to suppuration.

No loss of continuity perceptible.

No constitutional symptoms.

Use of syringe not usually painful.

Under treatment, the discharge rapidly diminishes, until only a drop or two of muco-pus can be seen, and that chiefly in the mornings. This symptom is apt to linger in spite of all efforts to remove it, and is perhaps

¹ Dr. J. Nevins Hyde states very positively that "when a man exhibits a decidedly purulent urethral discharge, without coincident symptoms of unmistakable syphilis, he can be safely pronounced free from all danger of the last-named disease, provided always the period of incubation of syphilitic chancre has, in his history, already elapsed. Intra-urethral chancre need therefore never be mistaken for gonorrhœal disease, as the two affections are so distinct that a differential diagnosis can usually be satisfactorily established without the aid of the endoscope." (Chicago Medical Journal, August, 1880.)

the most persistent, and by reason of its long continuance the most annoying, consequence of this form of gonorrhœa.

There are, however, some complications which, although they may likewise appear during an acute attack, are often associated with this catarrhal condition of the urethra, and which are of considerable gravity. These are gonorrhœal rheumatism, gonorrhœal ophthalmia, and gonorrhœal conjunctivitis.

COMPLICATIONS OF CATARRHAL GONORRHŒA.

GONORRHŒAL RHEUMATISM, or URETHRAL SYNOVITIS, as it has been better called, may appear at any time during the existence of a purulent discharge from the urethra. It is much more common in men than in women. It develops suddenly, and is usually accompanied by some abatement of the discharge, more rarely by its entire disappearance. The disease has been ascribed to various causes—metastasis, reflex agency, identity of gonorrhœa and syphilis, development of a pre-existing rheumatic diathesis, and, finally, a mild form of septicæmic infection.

The majority of these hypotheses are untenable. If the disease were due to metastasis, the original affection should disappear, but, as has been said, this is only of exceptional occurrence; if it were a result of reflex action, other forms of genital irritation, balanitis, phimosis, etc., should produce it, but this is not the case. That it is not an evidence of the identity of gonorrhœa and syphilis, has been proved by inoculation, and is evident from the fact that it often follows traumatic urethritis; this view is hardly worthy of formal refutation. There is often no discoverable connection between this form of rheumatism and any tendency, hereditary or acquired, to rheumatic disease; my own experience has amply convinced me of this fact. Besides, as will be seen, there are broad distinctions between this disease and ordinary rheumatism.

We have remaining, then, the theory of septicæmia, which there are several reasons for favoring. If the joint troubles do result from the absorption into the blood of septic matters arising from pus decomposition, we can understand the otherwise mysterious fact of their much greater frequency in the male than in the female, the length, narrowness and delicacy of the male urethral canal offering admirable opportunities for the retention, decomposition and absorption of purulent matter, as contrasted with the short urethra of the female, or with the thick, resistant, non-absorbent, vaginal mucous membrane. We can also understand the obstinacy of this affection under ordinary anti-rheumatic treatment; its occurrence by preference in those cases in which long-continued suppuration has given the best chances for absorption to take place; its appearance with successive attacks of gonorrhœa, no rheumatic symptoms being noticed in the intervals; its variations from the course of common rheumatism—its predilection for one particular joint, etc.—so that it seems safe to say that, although not absolutely proved, the septicæmic theory is probably the correct one.

Dr. Wilks believes that gonorrhœal rheumatism is usually a subacute form of pyæmic inflammation. He considers it analogous to scarlatinal rheumatism, which is often nothing less than severe pyæmia, traceable to purulent infection from the sores in the throat; he also compares it to puerperal rheumatism, and to that form which sometimes follows smallpox. In support of the pyæmic origin of gonorrhœal rheumatism, Wilks refers to two cases in which obscure fatal pyæmia proved to have for its cause a gonorrhœal inflammation of the urethra, the evidence of this being the discovery of a purulent inflammation of the prostatic plexus of veins while the urethra was full of pus.

Dr. Da Costa says, in a clinical lecture, "This case demonstrates what I am in the habit of teaching, that gonorrhœal rheumatism is, in truth, a form of pyæmic rheumatism, involving special features, and requiring special treatment."¹

Senator considers that the most probable explanation is that the inflammatory irritation is gradually propagated from the urethra to the sacral plexus and the spinal cord, where it affects trophic nerve fibres. Gonorrhœal urethritis would thus be assimilated to those articular disorders which occur in diseases of the spinal marrow.²

Agnew teaches that it is septicæmic in its character.³

The *symptoms* of this complication come on rapidly, usually during the later stages of either an acute or catarrhal gonorrhœa. The patient, without any premonitory signs, or perhaps after a slight chill or "creep" and a little febrile disturbance, notices pain and swelling in an articulation, commonly the knee, ankle, wrist, or elbow, in order of frequency.⁴ Within a few hours the swelling, due to synovial exudation,⁵ increases, the joint becomes moderately red and hot, and very tender, the suffering on touch or movement being great. It may remain in this condition for some time, may involve neighboring tissues, producing a general arthritis, or may in a very few cases subside rapidly. There are few if any constitutional symptoms.

The disease in a certain number of cases only develops vague travelling pains in joints, bones, and muscles, and does not produce well-marked local symptoms.

"In the Archives Générales de Médecine for May, 1881, MM. Duplay and Brun discuss a form of gonorrhœal arthritis which, according to them, has not before been fully described. This variety of arthritis may come on suddenly, without any known immediate cause, or it may follow slight injury. Most frequently, however, it is preceded by malaise, slight fever, loss of appetite, etc. The first symptom is pain, which comes on with great acuteness. The pain begins, and is always worst, just at the spot where the articular surfaces of the bones touch each other, and is increased at night. Besides this spontaneous pain, acute suffering is caused by pressure above the joint. Swelling soon follows the pain, and it also first appears exactly at the line of junction of the bones which form the joint. There is little or no effusion into the synovial cavity, the swelling being chiefly due to infiltration of the periarticular tissues. The œdema extends above and below the affected joint, and sometimes there is an obscure kind of fluctuation, leading to a suspicion of abscess. Two cases are mentioned in which incisions were made under this belief. The swelling is not due to effusion into the sheaths of the tendons. In the treatment of this form of arthritis, the most important point is absolute rest of the joint by means of a plaster-of-Paris bandage. The pain then soon disappears, and, in favorable cases, the joint recovers almost entirely. If, however, the joint be not fixed until several days after the onset, more or less stiffness is likely to remain; and if the affection be neglected altogether, ankylosis will probably occur; indeed this sometimes happens in spite of careful treatment. The wrist and the elbow appear to be the joints most frequently attacked, while the knee, which is frequently the seat of the effusive form (hydrarthrosis), is comparatively seldom involved. However, any joint may suffer, and the authors have seen marked examples of this form of arthritis in the metacarpal, phalangeal, and sterno-clavicular articulations. But whatever joint is attacked, the symptoms are essentially those which have just been described. The paper concludes with notes of six cases (three of the

¹ College and Clinical Record, July 15, 1881.

² Ziemssen, Cyclopædia of Practical Medicine, vol. xvi. p. 73.

³ Op. cit. vol. ii. p. 474.

⁴ In one hundred and twenty cases of gonorrhœal rheumatism tabulated by Fournier, the whole number of joints affected was two hundred and twelve: the knee eighty-three times; ankle, thirty-two times; fingers and toes, twenty-five times. He divided the diseases into three varieties: (a) A monarticular hydrarthrosis; (b) A more generalized affection resembling ordinary rheumatism, but more stationary and protracted, less mobile, unattended with marked constitutional symptoms, etc.; (c) Vague general pain without much structural alteration.

⁵ M. Gosselin says, "It is very rare that we find exudation in an articulation in consequence of a blennorrhagic arthritis." (Gazette des Hôpitaux, No. 17, 1881.)

patients being women), illustrating the various points already mentioned; the chief features of this form of joint-affection are the occurrence of pain and swelling, which always begin and remain most marked exactly at the interarticular line, the presence of crackling, and the liability to ankylosis if the joint be not fixed early."¹

Ordinary rheumatism is the only disease for which this form of joint affection is likely to be mistaken. The diagnosis should be based upon the following points which, for convenience sake, may be tabulated thus:—

GONORRHOEAL RHEUMATISM.

Associated with urethritis.
Very infrequent in women.
Constitutional symptoms transient and not severe.
Very little fever.
No sweating.
Urine unaltered.

Often associated with scleritis, bursitis, and teno-synovitis.

Cardiac lesions rare.²

Inflammation remains fixed; involves one or a few joints.

Local pains rather less than in true rheumatism.

Effused fluid is absorbed very slowly.

Tendency to hydrarthrosis after acute stage has passed.

Great tendency to relapse during subsequent gonorrhœas.

Anti-rheumatic remedies are unavailing.

ORDINARY RHEUMATISM.

Not associated with urethritis.

Not very rare in women.

Constitutional symptoms marked and prolonged.

High fever.

Profuse sweating.

Urine high-colored and loaded with urates.

Not complicated with scleritis, bursitis, or teno-synovitis.

Cardiac lesions frequent.

Inflammation jumps from one joint to another, involving many.

Pains always severe.

Effused fluid absorbed with comparative rapidity.

No tendency to chronic hydrarthrosis.

Relapses have no association with urethral conditions.

Anti-rheumatic remedies are evidently useful.

The *sciatica* which is described as often associated with gonorrhœal rheumatism, is in all probability a symptom of involvement of the hip-joint, although here, as in many other cases, the diagnosis between commencing arthritic trouble and an inflammation of the fibrous sheath of the nerve is well nigh impossible.

The varieties of gonorrhœal rheumatism, other than that described, have been classified into the *arthritic*, in which the swelling, instead of depending upon the presence of effusion into the synovial sac, or *hydrarthrosis*, is due to a thickening of the capsular and subcutaneous tissues of the articulation; the *arthralgic*, in which the swelling and inflammation are slight, and the pain is rather neuralgic in character; and the "*knotty*, or *pseudo-gouty*," in which the phalangeal joints become enlarged and distorted. The first of these has always, in my experience, been preceded by a synovial effusion, and has been the result of protracted continuance of the joint trouble. I have never met with the last variety, and must be permitted to doubt its existence as a complication of gonorrhœa.

GONORRHOEAL OPHTHALMIA AND GONORRHOEAL CONJUNCTIVITIS.—Associated with these joint troubles in many cases, or occasionally occurring as the only

¹ London Medical Record, October 15, 1881.

² Dr. Pfuhl reports (*Deutsche Zeitschrift für pract. Med.*, No. 50, 1878) seventeen reliable cases of endocarditis following gonorrhœa, and adds one to the number. Dr. Cianciosi also records a similar case (*Bullet. dell. Scienz. Med.*, Sept. 1880). Examples of gonorrhœal endocarditis have also been noted by La Cassagne, Désnos, Marty, and Baudin.

complication of a urethritis, there is an inflammation of some of the structures of the eye, known as *Gonorrhœal Ophthalmia*. The sclerotic coat, the iris, and the oculo-palpebral conjunctiva, are the tissues chiefly affected—the symptoms being those of a common iritis or conjunctivitis, attended with considerable aching pain, and accompanied by only a moderate amount of muco-purulent discharge. The usual remedies have a beneficial effect, but the disease tends to run a rather chronic course, and finally to subside spontaneously.

This complication should not be confused with the very different and much more serious condition of *Gonorrhœal Conjunctivitis*, although they are often spoken of as identical. The latter trouble is a result always of direct inoculation, the pus being transferred by the finger or otherwise to the edge or inside surface of the lids. The symptoms commonly make their appearance within a few hours, and are at first like those of a simple catarrhal conjunctivitis. They increase, however, with almost incredible rapidity, so that an eye which twenty-four hours previously was entirely healthy, will be found with tense, swollen, œdematous, bulging, erysipelatous-looking lids, from between the closely-approximated edges of which a thick purulent secretion is oozing; on separating them the conjunctiva is found injected and chemosed, and bathed in pus. In a short time, if the chemosis is not relieved, the supply of blood being cut off from the cornea, the latter ulcerates in one or more spots, or may become detached and fall out entirely, permitting a complete loss of the contents of the globe. This whole series of phenomena may occur within three or four days, and not infrequently has occupied only half that time. The pus from such an inflammation is intensely contagious, irritates the cheek over which it flows, and will, to a certainty, affect the sound eye if any be allowed to come in contact with it. (See Plate XVI. Figs. 2, 3.)

It is of great importance that, from the very onset of the disease, it should be distinguished from the mild, self-curable affection which we have described. The main points of difference are contained in the following table:—

GONORRHOËAL CONJUNCTIVITIS.

Produced by contagion only.

Occurs once in seven hundred or eight hundred cases of gonorrhœa.

May be derived from a second person by pus inoculation.

Involves one eye primarily.

Remains limited to eye originally affected, unless the other is accidentally inoculated.

Symptoms affect the conjunctiva from the start.

Symptoms of greatest gravity and urgency.

No association with subsequent gonorrhœa.

No relation to joint troubles, or other rheumatic manifestations.

Tendency to rapid destruction of tissues involved.

Treatment very useful; should be prompt and energetic.

This form of conjunctivitis does not differ in any of its essential features from *Ophthalmia Neonatorum*, or from the ophthalmia which has been artifi-

GONORRHOËAL OPHTHALMIA.

Produced probably by septicæmic infection. Has no relation to direct contagion. Occurs once in fifty or sixty cases.

Can only occur in a patient having urethritis.

Involves both eyes usually.

Frequently passes from one eye to the other.

Symptoms affect the fibrous tissues, the sclerotic coat, and iris.

Symptoms mild, subacute.

Frequently returns with each later attack of gonorrhœa.

Most commonly found to coexist with some other form of gonorrhœal rheumatism.

Tendency to final but slow cure.

Treatment not very effective; should be mild and expectant.

cially produced by inoculation of purulent secretions, and, as has been said, affords therefore no evidence of the specific nature of gonorrhœa.

The treatment of this, together with that of all the complications that have been detailed, will be described hereafter.

IRRITATIVE OR ABORTIVE GONORRHŒA.

There remains to be considered the third variety of so-called "gonorrhœas," the *irritative*, or "abortive." Not infrequently after a suspicious connection, a variable interval having elapsed, a patient will present himself complaining of a slight stinging pain on urination, and a little itching or tingling at the meatus. An examination discloses a slight reddening, possibly a little swelling of the lips of that orifice, and a little transparent or very moderately turbid secretion coming from the anterior half-inch of the urethra, and only made to appear at the meatus by firm pressure from behind forward. These symptoms are very similar to those of the earliest stage of an acute urethritis, and indeed are altogether indistinguishable from them, a fact of importance in deciding as to the propriety of "abortive" treatment. Instead, however, of increasing in intensity, and progressing to decided ardor urinæ, chordee, vesical irritation, etc., they remain *in statu quo* for some days, and then, if not aggravated by improper treatment, subside entirely, the whole duration of the case not exceeding a week or ten days. There are no sequelæ and no complications associated with this condition, which is simply one of mucous irritation and consequent hyper-secretion. It is these cases which give their best opportunities to those charlatans who report cures of gonorrhœa in incredibly short periods, and who can always muster enough of such irritative cases to give a semblance of truth to their assertions.

The three varieties of urethritis which have thus been described, may be contrasted as follows; it being understood that such accurate clinical differentiation does not invariably occur, but that in many cases the characteristics of the different classes are intermingled. The tabular form will be useful in enabling us to recognize at a glance the main points of difference.

ACUTE INFLAMMATORY URETHRITIS.	CATARRHAL URETHRITIS.	IRRITATIVE URETHRITIS.
Usually a first attack.	Usually a second or subsequent attack.	No relation to previous urethral disease.
Begins with a little redness, pouting, and tingling, itching, or smarting at the meatus.	The same.	The same, but to a much less degree.
Rapidly develops free discharge, ardor urinæ, chordee, and other symptoms.	Most of these symptoms, with the exception of the discharge, are absent.	All of these symptoms absent; does not progress beyond this point.
Discharge thick, yellow, greenish, or bloody.	Discharge milky or watery.	Almost no discharge.
Usual complications : Prostatitis. Cystitis. Bubo, etc.	Most common complications : Rhenmatism. Ophthalmia.	No complications.
Treatment at first actively sedative and antiphlogistic.	Treatment may soon be "anti-blennorrhagic;" eubebæ, copaiba, etc., with injections.	No treatment necessary.

ACUTE INFLAMMATORY URETHRITIS.	CATARRHAL URETHRITIS.	IRRITATIVE URETHRITIS.
Often subsides permanently with much rapidity.	Apt to be followed by a drop of gleet discharge in the mornings.	Lasts only a few days.
Usual sequel: chronic gonorrhœa, depending on a patch of granular urethritis.	Usual sequel: gleet, depending on a submucous deposit of fibrous tissue.	No sequelæ.

CHRONIC URETHRAL DISCHARGES.

We have thus far been occupied with the *acute* affections of the urethra; but as a direct continuation or prolongation of these, or as more or less remote sequelæ, a number of *chronic* urethral discharges are met with. These may for convenience be divided into three classes: those due to a *urethral catarrh*, a condition often left after the subsidence of an acute urethritis; those dependent upon a *chronic gonorrhœa*, the inflammation having localized itself in some portion of the urethra, producing a granular or even superficially ulcerated surface; and those commonly known as *gleety*, which in almost every instance will be found associated with urethral coarctations, often of the sort known as “strictures of large calibre.”

Nearly all chronic discharges arising from the urethra proper will be found to fall under one or the other of these heads, and as it is a matter of much therapeutic importance to be able to distinguish them, their chief diagnostic points may be briefly considered. Of course, it is understood that prostatic, vesical, and other discharges which may at times appear at the meatus, are not here referred to.

URETHRAL CATARRH.—After many cases of gonorrhœa, for some time after the disappearance of the last drops of muco-purulent discharge, there will still be found a condition of excessive secretion, or of increased “urethral moisture,” which will often be a source of unnecessary anxiety to the patient and the surgeon. The symptoms associated with this mucous catarrh vary from a mere feeling of wetness about the meatus, to the possible production, by “stripping” the urethra, of a drop or two of clear, albuminoid liquid, slightly tenacious, and resembling that resulting from a prostatorrhœa, with which, indeed, it is often associated. There is no gluing together of the meatus, and no pain or other subjective symptom, except the one alluded to—a sensation of dampness at the very extremity of the penis. This is often so marked as to lead the patient to frequent useless examinations of the organ, or to induce the belief that a free discharge exists, but is absorbed by the dressings or by the underclothing. Treatment of any sort, as a rule, serves only to aggravate or at least to perpetuate this condition, which, in nineteen cases out of twenty, will subside spontaneously in a few days or weeks. If, however, on the supposition that the urethritis is still active, or that he is dealing with a gleet, the surgeon continue treatment, changing from injection to injection, and employing the different anti-blennorrhagics, this state of affairs may be indefinitely prolonged. For this reason, if for no other, the statements of patients as to urethral troubles should always be revised by a careful inspection at each visit on the part of the surgeon himself.

CHRONIC GONORRHŒA.—In other cases, after all marked symptoms have vanished, there will yet remain a milky—or rather, creamy—drop, which can be pressed out of the meatus whenever a few hours have elapsed after urination.

This may come from any portion of the urethra, but will usually be found to proceed from the fossa navicularis, or from the anterior membranous portion. By "stripping" the urethra an inch or so at a time, gradually working backward, or by proper use of a bulbous bougie, as will be described under the head of treatment, a very definite idea of the exact site of the trouble may be obtained. The meatus will often be found a little reddened or swollen, there will be an undue warmth or even a slight scalding on urination, erections will be accompanied with a dull ache, and all these symptoms will be much increased by venereal, alcoholic, or other excesses, especially by prolonged and ungratified sexual excitement and by the free use of spirituous liquors of inferior quality. There is no interval between this condition and the last stage, or rather the previous stage, of an acute urethritis.

GLEET.—In some cases, and especially in those in which the gonorrhœa has been of long continuance, or has been frequently repeated, there will occur another group of symptoms, chief among which is a "gleety" or muco-purulent discharge. In the mornings, the lips of the meatus will be found glued more or less tightly together, and on separating them, a drop of opalescent, whitish fluid will become apparent, or may be squeezed out. There will probably be no pain at any time, unless micturition be attempted in the morning before the meatus has been opened by pulling apart its adherent margins; in that case, the same sort of momentary, lancinating pain may be felt, as is excited by only very moderately compressing the urethra at any point during urination.

The discharge may be more profuse, but cannot usually be found during the day in sufficient quantity to be made apparent at the meatus, owing to the frequent washing out of the urethra by the stream of urine. There will often be found associated with this discharge, a few other symptoms, notably a dribbling of urine at the end of micturition, an increased frequency of the latter act, and a few vague lumbar or hypogastric pains or aches.

This group of symptoms is one of great importance to both practitioner and patient—to the former because, unless they are observed and their cause ascertained, treatment will often be so unsuccessful as to reflect discredit or result in the loss of the patient; to the latter because they indicate the preliminary or formative stage of a condition which, at a later period, becomes of grave pathological importance, and also because, if the condition be at any time curable, it is just when it begins and may be recognized by these phenomena, a rational explanation of which involves the consideration of the so-called "strictures of large calibre." As the very existence of this form of stricture, or at least the possibility of its being a factor in the production of disease, is not infrequently denied, and as any experience, however moderate, with gonorrhœal cases will involve the management of those I am now describing, it will not be out of place here to run over the main points at issue.

STRICTURES OF LARGE CALIBRE.

To account, then, for the symptoms we have detailed, and for the existence of their essential cause, there are certain general physical and physiological laws which should be taken into consideration. Persistent irritation, such as results from frequent or protracted gonorrhœas, causes at any given point in the body an increase in the fibrous tissue of that region, and the deposit or development of new tissue of a similar character. This is especially true of mucous and submucous surfaces, and still more particularly of the urethra, which, by the anatomical peculiarities already mentioned, offers peculiar facilities for the production and organization of inflammatory products.

Such a deposit occurring in the submucous structures around the urethra, interferes to a greater or less extent with the lumen of that canal, and thus constitutes a stricture. Once deposited, here as elsewhere throughout the body, this new tissue tends to contract more or less steadily and continuously. This is in consonance with a well-known pathological law, and the contraction is no more noticeable here than when it occurs in the intertubular spaces in interstitial nephritis, strangulates and destroys the parenchyma of the liver in cirrhosis, produces induration and bronchiectasis in chronic pneumonia, limits the movements of inflamed joints, distorts or deforms after burns and scalds, or in any of the many possible directions exerts its power in the production of disease. We have, then, it must be admitted, in urethritis, a sufficient cause for the production of a condition which tends gradually to diminish the size of the urethra and to interfere with its dilatability.

In studying the effect of this condition in producing the symptoms that have been detailed, certain other physiological laws must be taken into account. For example: Habit is a powerful agent in facilitating and controlling the functions of animal life. Illustrations of this fact in other systems than the genito-urinary are frequent and familiar. The evacuation of the bowels at certain hours of the day, and the difficulties resulting from inattention to their requirements; the easy and unnoticed digestion of food taken at proper intervals, and the anorexia and dyspepsia following irregularity in this respect; the imperceptible and uniform action of the heart under ordinary circumstances, its tumultuous and uneven palpitation when its work is suddenly increased; the many apparently trivial agencies which are notably sufficient to interfere with the mental processes when accustomed routine is broken into; all these are a few of unlimited examples that might be adduced to show the force of habit in influencing the mode of performance of such functions.

To take up the case in question, it is safe to say that, in a healthy adult, a certain equilibrium has been established and maintained between the usual efforts and powers of the bladder as an expulsive organ, and a certain average amount of resistance which must be overcome before it can empty itself. At the age of twenty-one years, this adjustment of force depends upon a large number of previous distinct acts of micturition—about thirty thousand if an average of four daily be taken. This balance between the force of expulsion and its work cannot with impunity be disturbed, and even a slight interference with the calibre of the urethra tends to produce such disturbance.

Apart from the proclivity to muscular spasm in the neighborhood of and behind every stricture, this interference with the action of the bladder arises from the encroachment of the new deposit upon the urethral calibre. It is a law of hydrostatics that, if a current of liquid be passed along a tube, a certain degree of friction proportionate to the amount and velocity of the current and the size of the tube takes place between the walls of the latter and the liquid; if the tube be narrowed at any one place, the friction is increased at that point, and, to avoid a diminution in velocity, the propulsive force behind the liquid must also be correspondingly increased. The pain excited by the very simple experiment of moderately compressing the urethra during micturition, will serve to illustrate the bearing of this fact, as does also the exceedingly slight amount of prostatic enlargement which often suffices to bring on vesical troubles.

Still another point must be mentioned before we recur to the group of symptoms the occurrence of which, after so many cases of gonorrhoea, we are endeavoring rationally to explain. The act of micturition is one requiring for its perfectly normal performance, first the relaxation of certain muscles to secure patency of the urinary channel, and next the thorough and complete

contraction of those muscles to produce entire evacuation of the contents of the passage, "which would otherwise leave it *guttatim*." The latter portion of this act is accomplished by the contraction of the circular muscular fibres which surround the urethra, and which, during the intervals of urination, in a healthy condition, serve to bring and retain its walls in close apposition. The submucous deposit which increases the friction of the stream of urine at any point, also interferes with the accurate closure of the canal by those muscles whose action is impeded, and whose structure itself is in part often invaded, and as a consequence we have imperfect emptying of the urethra at the end of urination. Finally if, in addition, we recall the intimate nervous connection of the urethra with all the viscera of the abdomen and pelvis, and with the walls of those cavities, and the mutual relation which exists between them, tapeworm having been known to cause all the symptoms of stricture, and stricture of very moderate degree having, as in a case I have recently seen with Dr. Wm. Pepper, produced intestinal irritation with dysenteric symptoms, we are in a position to sum up the relation of the pathological and subjective phenomena as follows:—

The increased friction and resistance resulting from even a slight fibrous peri-urethral deposit, disturb the normal relations of the bladder, and, by rendering it irritable, bring on one of the common symptoms of stricture, frequent micturition.¹ The imperfect closure of the tube, the muscular action of which at the point of deposit is materially interfered with, causes the equally imperfect expulsion of the last drops of urine, and produces another characteristic symptom, dribbling at the end of micturition. The retention and decomposition of these last drops, together with the abnormal friction between the stream of urine and the urethral walls, give rise to a subacute inflammation of the mucous membrane, accompanied with a catarrhal or muco-purulent discharge, constituting the condition of *gleet*; by reflex irritation transmitted from the area of inflammation, pains in remote organs and situations are developed, notably in the lumbar and hypogastric regions.²

This relation of causes and effects has been in the main accepted as correct by the profession for many years. Probably no one denies that in certain strictures in which the urethral calibre is markedly diminished, the connec-

¹ That the same condition of irritable bladder may be produced in the female from a similar cause, is shown in the following case reported by Dr. Matthews Duncan (Medical Times and Gazette, Nov. 16, 1878). "A woman came to us suffering from irritable bladder. She had to make her water frequently, sometimes every few minutes. It was not a case of hours, but of minutes, and she could not get good sleep. On examining this woman we found that there was no orifice of the urethra in the natural situation. She had no history of syphilis, of operation, or of injury; yet there was no orifice in the situation of the urethra. A little to the right side of the natural position of this orifice was a very slight redness. A little surgical probe pressed against this redness entered the bladder. The orifice of the urethra, then, was strictured. On examining the woman's bladder, we found it not expanded. It was a large bladder, but not larger than you frequently see in healthy women; but we found the urethra expanded. The bladder-cavity did not begin at the internal orifice of the urethra, but its expansion began at the external orifice. There was no urethral canal. The bladder was not inflamed in any degree; it was soft, not tender, and large, though not unnaturally large. Now, here is a very plain case. A little operation was performed with a bistoury, enlarging the external orifice of the urethra, so that a number 15, 16, and then 18, were passed into the bladder. Within two days the canal of the urethra had re-formed itself; and from the moment of the operation the woman was cured. She slept that night, she had no irritability of the bladder at all, and made no complaint. She remains cured."

Dr. Mastin, of Mobile, who has made the interesting observation that cases of constricted meatus are excessively common among the Jews, a result as he believes of early circumcision, has found also that the evils associated with this condition are chronic urethral discharges, irritable urethra, spasmodic stricture, frequent micturition, etc. The average size of the meatus in his cases was something below twelve millimetres.

² Van Buren and Keyes record (op. cit., p. 76) a curious case in which a stricture, calibre 13, $3\frac{1}{2}$ inches from the meatus, gave rise to distinct soreness of the mammae. This was unaccompanied by structural change, and disappeared when the stricture was dilated.

tion between the pathological changes and the observed indications is about as has been stated. The differences of opinion which now exist are chiefly as to the *amount* of urethral contraction which is sufficient to produce noticeable effects, and here the argument must rest upon clinical observation supported by the results of autopsies.

I have now under occasional treatment a curious case showing the effect on the genito-urinary tract and its functions, of a seemingly insignificant encroachment upon the urethra. A gentleman thirty-five years of age, and of unusual physical vigor, has had at intervals of some months several recurrent urethral polypi, sessile, not rising above the surface of the urethra more than a line at the most, perfectly soft, almost gelatiniform, just within the fossa navicularis, and themselves entirely insensitive. These I have now on four occasions during the last three years snipped off, touching the bleeding point afterwards with a drop of nitric acid, after which there has been a period of freedom from annoyance, followed by a return of the polypi, which have been pronounced by Dr. Formad to be typical soft papillomata. The peculiar feature of the case is that, immediately upon their re-growth, my patient experiences certain well-marked symptoms, by which he is always able without inspection to recognize their presence. He has a slight tingling on urination, sometimes a little burning, vesical irritability, and, most marked of all, unnatural sexual excitability—erection and emission on the slightest provocation, premature ejaculation on attempts at intercourse, etc.—all these phenomena disappearing in each instance within a week after the removal of the minute growth. I was at first skeptical as to the association of the conditions, and was inclined to think it imaginary, but the repeated occurrence of the symptoms and their unvarying relief by the operation have convinced me of the contrary.

I have seen and reported¹ a case in which, as shown at the autopsy, a stricture of the calibre of 24 mm. had produced congestion and ulceration of the urethra, dilatation and hypertrophy of the bladder, and dilatation of the ureters; this stricture had been recognized during life. Death resulted from an intercurrent disease.

Recently, after consultation with Dr. Agnew, and with his approval, I performed internal urethrotomy for the relief of annoying symptoms due to a stricture which would readily allow the passage of a No. 32 steel sound, but which re-contracted with rapidity, after dilatation. The operation was followed by immediate, though only temporary, relief.

I have at present under treatment a gentleman who, for three years past, has been continuously affected with albuminuria, which has caused him great anxiety, and has in some respects modified his entire life. He had been under the care of several practitioners in Philadelphia and New York, all of whom seem to have attributed his condition to congestion of the kidneys. His urethra had never been examined. A No. 26 bulbous bougie revealed the existence of two very slight strictures, through which the instrument passed readily, one at $3\frac{1}{2}$ inches, the other at 5 inches from the meatus.

At the time of his first visit to me (April 24, 1882), this patient's urine contained from one-twelfth to one-tenth its bulk of albumen, a small quantity of pus, and a number of casts, either mucous or granular. At that time the diagnosis of both myself and Dr. Formad, who has examined for me a number of specimens of urine in this case, was that the condition was probably one of interstitial nephritis. I proceeded to dilate this patient's urethra gently, and in two weeks all trace of albumen had disappeared, as had also the pus cells and casts, and they have not since recurred, as shown by examinations of the urine repeated at intervals of a few days. The patient himself, who has been in the habit of using the tests by boiling and by nitric acid, says that it is the first time for three years that the albumen has been absent. No other treatment has been employed. These cases bear directly upon the question of the significance of slight urethral coarctations, and are worth recording, although, after a somewhat large experience with this class of ailments, I believe them to be very exceptional.

That every urethral coarctation following on urethritis must at some time have been a stricture of large calibre, is self-evident, but just when such a stricture becomes an active pathological factor, and is able in the manner indicated to give rise to symptoms, is an unsettled point. Indeed, it is not

¹ Philadelphia Medical Times, May 26, 1877.

probable that it ever can be definitely determined in a mathematical sense. The idea that any particular fixed calibre represents the normal condition of the urethra has long ago been abandoned, the observed variations of that canal being such that no special dimensions can be assigned to it as representing the precise dividing line between health and disease. The old method of regarding the size of the meatus as an indication of the normal calibre of the canal behind it, is also unquestionably fallacious, it having been conclusively shown that no more definite relation exists between them than between any other mucous canal and its corresponding outlet, the mouth and the œsophagus for example, or the anus and the sigmoid flexure. That there is a certain correspondence between the size of the urethra and that of the flaccid penis, is true, the calibre of the one increasing with the circumference of the other, but that this ratio is present in any absolutely unvarying manner, has not yet been demonstrated. At the most, the size of the penis may be said to furnish a general indication of the urethral dimensions, but one which is approximate merely. On the other hand, it has been shown that there are usually certain normal variations even in the spongy portion, which is now claimed with much show of truth as the most frequent seat of pathological contractions, and that it is impossible with any of the means at our command to distinguish between these natural irregularities and coarctations of equal calibre due to incipient stricture.

The discussion of these opposing views, neither of which is without its errors, would exceed the scope of this article, but I may here repeat a statement which I have already made elsewhere, that in my opinion, although our knowledge is insufficient to determine in every case the exact nature or pathogenetic value of any given slight diminution in urethral calibre, *unattended with symptoms*, yet we have abundant evidence, clinical and post-mortem, to enable us to advance, with little risk of contradiction, the following propositions, applicable to the vast majority of cases:—

I. A patient who, after an attack of gonorrhœa, develops the condition which we have described as gleet, especially if the discharge be accompanied by the other symptoms of the group, has, in all probability, a commencing stricture.

II. If a careful examination with a bulbous bougie reveal any abnormal constriction, it may, with confidence, be considered as due to a fibrous deposit in the submucous tissue, and the symptoms may be referred to it.

III. This condition, though yielding readily to proper treatment, is sometimes, if neglected, productive of serious consequences, which, in very rare instances, may even imperil life, through continuous irritation of that portion of the genito-urinary tract which is posterior to the contraction.

DIAGNOSIS OF CHRONIC URETHRAL DISCHARGES.

Fig. 318.



Bougie-à-boule,
or bulbous-pointed
bougie.

It is evident from the foregoing, that, to arrive at a definite conclusion as to the character and cause of any particular chronic urethral discharge, it will often become necessary to resort to the use of bulbous-pointed bougies, which, for purposes of diagnosis, are of all urethral instruments the most valuable. They may be made of metal with slender stems, having small expanded ends or handles, upon which the number of the instrument may be marked; this should represent in millimetres the circumference of the shoulder of the bulb.

More satisfactory instruments are, in my opinion, the flexible gum bulbous-pointed bougies figured in the annexed cut (Fig.

318). The shoulder of the bulb should join the shaft at almost a right angle, and not with the large obtuse angle often found in improperly shaped instruments. The size selected for exploration should be determined approximately in the manner already mentioned, by noting the circumference of the flaccid penis. The scale which I have adopted for use, and which differs from that published by Dr. Otis in giving a lower grade of numbers, is as follows:—

A penis 3 inches in circumference at the middle of the spongy portion, indicates a urethra which should normally admit an instrument of about 26 to 28 millimetres in size; when it is $3\frac{1}{4}$ inches, the urethra should have a calibre of from 28 to 30 mm.; $3\frac{1}{2}$ inches, 30 to 32 mm.; $3\frac{3}{4}$ inches, 32 to 34 mm.; 4 inches, 34 to 36 mm., beyond which size it is seldom necessary to go.

If the meatus be too small to admit of the introduction of a bulbous bougie of the required size, it should be enlarged. The penis should then be grasped just behind the corona, and held gently between the thumb and finger of the left hand, the foreskin if redundant having been retracted. The dorsum of the penis should face the abdominal wall. The bougie well oiled should then be passed gently into the bladder. If arrested, the point on the shaft corresponding to the meatus should be marked, the distance from that to the bulb representing the position of the anterior face of the stricture. If that instrument or a smaller size passes through, it should then after a moment's delay be withdrawn, and if during its outward passage any contraction is found other than that at the triangular ligament, which has been shown¹ to be normal, it is probably due to stricture—though spasm, which often relaxes after a few seconds, or shifts its position in the canal, as measured from the meatus, may give rise to errors in diagnosis. It cannot always with certainty be recognized. If the urethral discharge in the case undergoing examination be due to chronic gonorrhœa, the instrument will reveal a sensitive, roughened spot, but will impart no distinct sensation of resistance. In either case there will usually be some pus brought out on the shoulder of the bulb. In chronic gonorrhœa, this is apt to be stained with a few drops of blood.

The treatment of these conditions will be considered elsewhere, but as regards diagnosis, we may now bring together the main points of difference between the various chronic urethral discharges.

URETHRAL CATARRH.	CHRONIC GONORRHŒA.	GLEET.
Follows immediately on subsidence of gonorrhœa.	Continuous with attack of gonorrhœa, often a first one	Usually a variable interval after subsidence of gonorrhœa; generally after several attacks.
Discharge watery; thin mucus.	Discharge creamy; pus.	Discharge milky or milk-and-watery; muco-pus.
Not much affected by habits.	Greatly aggravated by excess in drink or by sexual excitement.	Increased by same causes, but not to the same degree.
No subjective symptoms.	Warmth or scalding on urination; very slight tendency to chordee.	Dribbling after urination; frequency of urination; hypogastric and lumbar pains.
Affects no special portion of the urethra.	Lingers chiefly about the navicular fossa and the bulbo-membranous junction.	Source ¹ of the discharge always back of the coarctation.

¹ Diagnosis of Urethral Stricture by Bulbous Bougies. By J. William White, M.D. Philadelphia, 1877.

URETHRAL CATARRH.	CHRONIC GONORRHOEA.	GLEET.
Cause: loss of tone and dilatation of capillaries of part.	Persistence of low grade of inflammation. Circumscribed congestion with small granulations.	Submucous deposit around urethra, interfering more or less with its calibre.
Prognosis: subsides without treatment.	Requires local treatment.	If cause be not removed, almost certainly grows worse.
Expectant treatment.	Treatment by local injections.	Treatment by dilatation and injections.
With bulbous bougie, urethra is found to be normal.	Point of sensitiveness, from which bougie brings pus.	Point of moderate resistance.

SEMINAL PLETHORA AND URETHRAL HYPERÆSTHESIA.

Before leaving the subject of the symptoms and complications of gonorrhœa in the male, an occasional source of error on the part of both patient and physician must be alluded to. In some cases, treatment is unnecessarily prolonged, and much annoyance is caused by the acceptance, without investigation, of the testimony of the patient as to the existence of a discharge. He will report that every morning, or perhaps only two or three mornings in the week, he discovers a drop of discharge at the meatus, which injections, bougies, anti-blennorrhagics, and other methods of treatment are powerless to dispel. Before concluding that this is an evidence of chronic gonorrhœa or of gleet, it would be well to inquire into the circumstances of the case. It should be remembered that patients suffering with acute gonorrhœa are compelled to make a sudden change in their sexual relations and habits. Previously, whether married or single, in the custom of indulging more or less regularly in sexual intercourse, they are at once absolutely cut off from this normal vent for seminal and other secretions. Superadded to this is the long-continued hyperemia of the entire genital apparatus, which tends to render such secretions more than usually abundant. Under these conditions, there is often produced a state of "seminal plethora," attended with certain symptoms which are rather those of health than of disease, but which may give rise to mistakes of diagnosis.

The enforced continence, the accumulation of the seminal fluids, the increased reflex excitability of the part, the handling, dressing, and injecting of the latter rendered necessary by the treatment, all combine to render nocturnal erections and emissions more than usually frequent. Very often the latter attract notice in the customary manner by disturbing the patient, or may even be associated with a distinct lancinating pain in the lumbar spine; but more commonly there will simply be an unusually firm, persistent erection in the morning on first awaking. This will subside in a few moments, and then, on "stripping" the penis, the drop of "discharge" makes its appearance. This is in many cases merely the result of a natural overflow of seminal and prostatic fluid; is such as often appears at the end of the penis in healthy males after prolonged, ungratified, sexual excitement; and does not, of course, furnish any indication for treatment. Careful inquiry, the association of the symptoms with the preceding erection, its absence on the mornings when erections fail to occur, and finally the failure to find with the bulbous bougie either the submucous deposit of gleet or the sensitive granular spot of chronic gonorrhœa, will serve to establish the diagnosis.

Such patients, when they are made to realize the true character of this phenomenon, should at the same time be guarded against the danger of falling,

as they sometimes do, into a condition of true sexual hypochondriasis. They should be told that their symptoms are compatible with a high degree of physical health, and are the natural result of certain agencies which can easily be explained to them. If, in spite of this, or in consequence of a mistake as to the meaning of these appearances, the patient does become hypochondriac, it may be necessary, while assuring him of the harmless nature of his symptoms, to administer some anaphrodisiac, preferably bromide of potassium, in doses sufficient to diminish the tendency to erection, and then gradually to withdraw it as previous habits are resumed.

URETHRAL ANÆSTHESIA.

The reverse of this condition is sometimes met with; that is, in place of urethral hyperæsthesia with frequent emissions, there is anæsthesia with an absence of sexual pleasure, and a slowness or infrequency of ejaculation even under conditions of natural gratification. This may be associated with nocturnal emissions. I have now under my care a patient, who has been seen by Dr. S. Weir Mitchell, and who, after several attacks of gonorrhœa, developed this condition. He is in no sense impotent, having firm, complete erections, and the genital organs are, to all appearances, normal. He is troubled with nocturnal emissions, two or three weekly, which are unattended with pleasure, or, indeed, with sensation of any kind. On attempting connection, he finds that it is only by vigorous and very persistent efforts that he is able to cause ejaculation, which, although normal as regards the quantity and character of the sperm, is barely perceptible to him, and is not followed by subsidence of the erection except after a long interval. He has no trace of stricture or other urethral trouble.

It has been suggested that this condition is due to an inflammatory change in the nerves supplying the prostatic urethra, as a result of which they have become insensitive, and that the nocturnal emissions are simply an overflow of accumulated genital fluids.¹

NEURALGIA FROM URETHRAL IRRITATION.

In still another class of cases, great sensitiveness along the course of the urethra persists, and may be associated with reflex neuralgic pains. In this condition of hyperæsthesia the urethra is sensitive to the touch, the use of instruments causes great suffering, and erections and emissions are painful. The neuralgias affect chiefly the sciatic and crural nerves, and are even more rare than the previous condition. Hemiplegia, ataxia, paraplegia, and other neuroses have been enumerated among the sequelæ of urethritis, but their connection seems to me more than doubtful. I have never seen any instance of such severe trouble, and the reported cases do not clearly show that the urethral affection exercised any definite causative influence.

In all cases of obstinate urethral neuralgia, spasm, or even discharge, in which no adequate cause can be discovered in the urethra or bladder, it is proper carefully to examine the rectum for worms, for hemorrhoids, and particularly for fissure. I have several times succeeded in this way in discovering and removing the cause of a protracted, painful and annoying condition, which had resisted months of treatment by

¹ Castelnau, quoted by Van Buren and Keyes, mentions a singular condition of prostatic and urethral anæsthesia—the patient having no orgasm, and being unconscious of the passage of semen—left behind by gonorrhœa, and coinciding with an inflammatory engorgement of the urethra. The normal sensation returned after several months.

injections, bougies, etc. Dr. C. A. Bryce records two cases of this character.¹ In a case of stricture occurring in a medical student, and associated with the most irritable urethra I have ever had occasion to explore or treat, great temporary relief was afforded by the division of the sphincter ani and consequent cure of a small fissure. Subsequently, however, hyperæsthesia returned, dilatation became impossible, and, after consultation with Dr. Agnew, I performed internal urethrotomy, which resulted in still further improvement. The patient is yet under treatment.

The great frequency of gonorrhœa rendering it extremely probable that, in any given case of nerve trouble, there has been an antecedent attack of this affection, should make us particularly careful not to employ the *post hoc, ergo propter hoc* method of reasoning.

TREATMENT OF GONORRHŒA IN THE MALE.

The treatment of gonorrhœa in the male requires for success, above all things else, the most careful attention to detail, and without this the best intended therapeutic agencies will invariably prove futile. I have heard a distinguished specialist remark, that for satisfaction in treatment and certainty in giving relief, he would rather manage any other kind of a case known to surgery; and Ricord's description of the infernal regions, as a place where the surgeon would be compelled to attend importunate patients with gleety discharges, has become proverbial. In spite, however, of such unfavorable utterances, I believe a large measure of success can be attained in the treatment of these cases by strict attention to certain points, which I shall make no apology for giving in some detail, in spite of their apparent triviality. It is chiefly to care in these respects that I attribute the fact, that for the past five years I have found that the time required for the treatment and cure of gonorrhœa has steadily diminished; and as I see in office, hospital, and dispensary practice several hundreds of cases annually, I feel justified in generalizing from them, and in assuming some authority of statement.

PROPHYLACTIC MEASURES.

It may not be out of place here briefly to allude to the various measures in vogue for the prophylaxis of gonorrhœa among those men who continually expose themselves to the chances of contagion. The use of a cover, immediate ablution, and urination as soon as possible after the completion of the act, are, it is needless to say, the most reliable means of prevention, and are so well known and so harmless as not to require further mention. An additional precaution, of which the same assertion cannot be made, is the use of one of the numerous so-called "preventive" injections. It is a cardinal doctrine of belief with many men that the prompt employment of some particular liquid, the receipt for which has usually been given them by a friend, will effectually prevent the development of venereal disease. This belief, in so far as it conduces to cleanliness, is of advantage; but whatever good it may do in this manner is far outweighed by the unfounded confidence often occasioned by the possession of such a seeming safeguard, and still oftener by the irritative effects produced by the injection itself. The favorite therapeutic classes to which these liquids belong are those of the antiseptics and astringents, carbolic acid, Labarraque's solution, alum and tannin, dilute Monsel's solution, and even a glycerite of iodine having to my knowledge been employed in this manner, the first mentioned with great frequency.

¹ American Specialist, February 1, 1881.

In those cases in which the injection is so weak as not to prove an actual irritant, its use, with the usual preliminary urination, is doubtless sometimes beneficial, serving to wash out the urethra. In the majority of instances, however, the extra-professional practitioners who recommend these measures fail to regulate the strength carefully, and, as a consequence, the injection often serves to increase any existing tendency to inflammation, or may itself be the exciting cause of inflammatory action.

Since they are useful only in promoting cleanliness, which can as well be attained without them—and as, on the other hand, they are often positively harmful—it is a good general rule to discountenance their employment. If, for any reason, it seems proper to prescribe a liquid to be used in this manner, great care should be taken to avoid making it of sufficient strength to irritate the urethral mucous membrane, and the patient should be instructed not to use it without dilution if it give rise to any burning or smarting.

CURATIVE TREATMENT OF GONORRHOEA.

In determining the proper treatment for existing gonorrhœa, it is necessary, in the first place, clearly to understand the character and stage of the case with which we are dealing. The classification which has been given will be found a good one for practical purposes, and nearly all cases can be assigned to one or other of the three classes: acute, subacute, and abortive.

To take them up seriatim, we may suppose that a patient belonging to the first or *acute, inflammatory* class presents himself for treatment, with the symptoms characteristic of the early stage: a red, swollen meatus, a little pain on urination, and a muco-purulent discharge. The propriety of employing in such a case the so-called “abortive” treatment at once suggests itself, but, in my opinion, should not at the present day be seriously considered, and for two reasons. In the first place, its theoretical claims depend upon the existence of a specific gonorrhœal virus, to destroy which by means of irritating injections, and thus to substitute a “simple” for a “specific” inflammation, is the aim of the treatment. Enough has been said at the beginning of this article upon the question of specificity; if the views there advanced are the correct ones, the abortive treatment is, from this point of view, unphilosophical and indefensible.¹ In the second place, even if that point were abandoned, there is a strong practical objection to the adoption of this method, in the impossibility which exists of accurately distinguishing at the outset between the different varieties of urethritis—one of which, beyond question, would be greatly aggravated by this treatment. As the most ardent advocates of the abortive treatment only recommend it at the very earliest appearance of symptoms, it is evident that in many cases a slight local irritation, limited to the very extremity of the urethra, and likely to subside spontaneously in a few days, would be converted into a general urethritis, which experience has proved is just as apt to be obstinate, protracted, and attended with serious complications, as an inflammation derived from pus contagion.

This treatment, then, which consists in the injection once or twice of a strong solution of nitrate of silver, or in the very frequent injection of weaker

¹ Lebert, who is a firm believer in the specificity of gonorrhœa, is compelled to write as follows about the abortive treatment (Ziemssen's *Cyclopædia*, vol. viii. p. 769): “Theoretically this method is quite satisfactory, since caustic fluids, such as nitrate of silver, often quickly produce a change for the better in acute and recent inflammations of mucous membranes. But this plan is not unfrequently followed by deep-seated, phlegmonous inflammation of the urethra, severe pain, and sanguineo-purulent discharge—in short, by all the signs of intense urethritis. If, therefore, we can by this means deprive gonorrhœa of its specific character, yet we substitute generally a more troublesome and dangerous malady than that which we had to treat.”

solutions of the same salt, or of some astringent such as tannin,¹ need not here be further described. Those cases in which it seems to have done good, and to have cut short the disease, are in all probability those belonging to the third or "irritative" variety, and in which, fortunately for the patient, the injections having failed to set up a very intense inflammation, the trouble had subsided as usual, though even then less promptly than it would have done without treatment.²

Having decided simply to treat symptoms as they arise, our first care should be to remove as far as possible all additional sources of irritation, chief among which are (1) the influence of motion, friction, and gravitation in increasing the amount of blood in the part; (2) the similar effect produced by sexual stimulus; and (3) the character of the urine which must necessarily come in contact with the irritated surface; this including, of course, the subject of diet.³

(1) To overcome the first, rest in the recumbent position is obviously the most important means at our command, and its power in limiting and subduing the intensity of an acute urethritis can hardly be over-estimated. To this power is due the comparative ease with which gonorrhœa can be cured in hospital practice, and I have several times seen threatening cases cut short by the development of some intercurrent disease which obliged the patient to take to his bed. Unfortunately, it is but seldom that this method of treatment can be adopted; business occupations, the pursuit of pleasure, and, above all, the desire to avoid detection, induce the patient to continue as nearly as possible his usual habits, and he rarely feels ill enough at this stage to welcome for its own sake confinement to bed or to a lounge. Nevertheless the general principle should be inculcated and insisted upon. The patient should be told to avoid, in every possible manner, physical exertion, to ride instead of walking, to sit instead of standing, and at such times as may be convenient to lie on his back with his hips elevated. As an inducement to stay at home and maintain this latter position, he may confidently be told that it will greatly reduce the severity and duration of the case.

¹ Niemeyer, *Text-Book of Practical Medicine*, vol. ii. p. 93.

² A harmless—but, in my experience, valueless—form of abortive treatment is that recommended by Dr. Kuechenmeister, of Dresden, who claims to have found liquor calcis, when properly diluted, extremely serviceable in the first stage of acute gonorrhœa. He uses it in the proportion of one part to four of water, and employs injections, beginning about the fourth day after an impure coitus, and repeats them every hour and a half during the entire day. He has found that the acute inflammatory symptoms usually subside after about twenty-four hours, but that the copious, painless discharge from the urethra is not lessened, and that the treatment, although aborting the first stage, must be replaced during the second stage by the ordinary astringent therapy. Dr. K. prefers, for the latter purpose, a solution of pure alum (10) in water (150), to be injected two or three times daily. (*New York Medical Record*, August 18, 1880; from *Deutsche medicinische Wochenschrift*.)

³ Dr. Louis Bauer, in an article in the *St. Louis Clinical Record*, after criticizing very severely the treatment recommended in Bumstead's work, and objecting more mildly to that employed by Van Buren and Keyes, thus sums up his views upon the subject: (1) "Gonorrhœa is indisputably a local disease. (2) The cause of gonorrhœa is local also, and of ephemeral duration. (3) Gonorrhœa is inflammatory in character, and if not disturbed by stimulating treatment, limited to the anterior portion of the urethra. (4) Primarily gonorrhœa affects the mucous membrane only. (5) Whatever may be the primary disintegration of the urethral lining by gonorrhœa, the structures involved are endowed with the power of spontaneous repair, that is to say, the reproduction of epithelium. (6) The reason why the erythematous inflammation of the urethral canal deserves special consideration and treatment is its special function to serve as an aqueduct for a saline fluid (urine)." Dr. Bauer advocates what he calls the "rational" treatment of gonorrhœa, the main points of which are: First. To protect the mucous membrane against contact with urine. Second. To dilute the urine by frequent bland beverages. Third. To reduce the inflammation and the hyperæsthesia of the nerve papillæ. This is undoubtedly very excellent treatment as carried out in the injection of an infusion of flaxseed and watery extract of opium, and in the use of demulcent watery drinks, alkalies, and saline laxatives. It is practically that which I have followed for many years, but without being able to obtain such excellent results as Dr. Mullen, of Indiana, who reports, that in nineteen out of thirty cases treated in this manner there was complete recovery in from five to twelve days.

(2) The patient should carefully and consistently avoid the companionship of women of any class, as under the circumstances there is apt to be an exaltation of sexual impulse which renders even the mere proximity of females more or less provocative of erections, or at least of a very harmful hyperemia of the parts. He should also, of course, endeavor to avoid lascivious thoughts, which, often engendered by the genital irritation already existing, react unfavorably upon it. Believing that functional rest is no less desirable in this ailment than in all other cases of acute inflammation, I do not hesitate to dwell upon the importance of this advice, or to urge upon the patient its strict observance.

(3) In order to render the urine as bland and innocuous as possible, rigid attention to certain dietary rules is indispensable. A skimmed-milk diet is beyond all question the one best adapted to this stage of the disease, and there is no patient who cannot, with a little self-denial, adhere to it for several days, or until all the more marked symptoms have subsided, and that without any very great inconvenience. A few farinaceous articles, or a little stale bread and butter, may be added if the feeling of hunger be obtrusive; but the more nearly the diet is made to consist of skimmed milk, the more likely is it that the patient will escape the severe ardor urinae and troublesome chordee of the first week or two. Here again, however, the natural anxiety to conceal the disease operates unfavorably. Very few men are so situated that they can make such sudden changes of diet without exciting unpleasant attention and criticism, and in most cases we are compelled to be content with a modification of their ordinary regimen.

Instruct the patient then to reduce his animal food to the minimum, to avoid all greasy, fried, or highly seasoned articles, to abstain from the use of pepper, of vinegar, of salt, of coffee, and of tea. Salad dressings, asparagus, in or out of season, acid fruits, tomatoes, strawberries, etc., pastry of all kinds, and indeed any article of food difficult of digestion, should be strictly prohibited, as should all malt, vinous, and spirituous liquors.

Bumstead interdicts the use of tobacco during the different stages of gonorrhœa, or permits it only in extreme moderation. The reasons he gives for this, however, are very unsatisfactory, as he refers¹ to cases of *spermatorrhœa* in which the symptoms were aggravated by smoking and chewing. The relaxing and sedative, and it may be added, anaphrodisiac, effects of tobacco, it seems to me, rather indicate its employment in the inflammatory stage, and I certainly have never seen any reason to think it did harm. Jullien,² after quoting Bumstead, and alluding to two cases in which tobacco was said to have been hurtful, published by Dr. Shipley,³ adds "We hasten to say that these statements are absolutely unechoed by French specialists."

The patient should be expressly warned against the use of beer and champagne, the two most hurtful, as well as most common, beverages among men of this class, and he should also be informed of the fallacy of the current opinion that gin, by virtue of its diuretic properties, is rather beneficial than otherwise.

If for purposes of concealment it is absolutely necessary that he should go through the form of drinking *something* containing alcohol, the least harmful article is probably weak claret and water. Apollinaris, seltzer, or soda waters are permissible drinks, and may be taken in large quantities, serving then the double purpose of diluting the urine and at the same time reducing the appetite, so as to render more easy the observance of moderation in eating.⁴

¹ Op. cit. p. 57.

² Op. cit. p. 50.

³ Bost. Med. and Surg. Journal, November 22, 1860.

⁴ Zeissl forbids not only beer and champagne, but all drinks containing carbonic acid in a nascent state, as he says that this gives rise to dysuria. (Medical Times and Gazette, Feb. 21, 1880.)

Ordinary drinking water may be taken in the same way, to the amount of three or four quarts daily, with great advantage, and, whenever it is impossible to enforce the milk diet, I make a point of insisting upon its use at this stage; and to meet the same indication—the reduction of the salts contained in the urine—it is well to prescribe some alkaline hydragogue diuretic, combining with it an arterial sedative, and an anodyne directed especially to the genital functions.

The importance of rendering the urine alkaline in the treatment of gonorrhœa is evident to any one who has carefully tested its reaction under varying conditions, as has been done in a number of cases by myself and others. Almost invariably an intense degree of ardor urinæ is associated with more or less decided acidity of the urine. Sometimes the alkalies administered do not seem to have the desired effect, and it was some time before I learned that to bring about and relieve alkalinity of the urine, it was necessary to give the alkaline salts *after meals*, and not during fasting. A series of experiments upon this point were made by Dr. C. H. Ralfe, and recorded in an excellent paper in the *Lancet*.¹ Long previously (in 1850), Dr. Bence Jones had shown that large doses of sesquicarbonate of ammonium actually increased the acidity of the urine. In 1854, Dr. W. F. Beneke made a similar observation as to bicarbonate of sodium, and in 1860, Professor Parkes recorded a like experience with bicarbonate of potassium. Dr. Ralfe, after carefully detailing his experiments, summarizes his results as follows:—

“The effect, therefore, of bicarbonate of potassium, taken after food, on the acidity of the urine, is different from that when it is administered before meals. For when taken on an empty stomach, we have seen that the acidity on the day of administration was only slightly depressed, whilst on the day following the acidity was considerably higher than it was the day before the salt was taken. But when it was administered during the process of digestion, the acidity of the urine entirely disappeared, being on two occasions neutral, and on one alkaline, whilst on the succeeding days there was no marked increase in the acidity of the urine as compared with that of the days preceding the experiment. And the same difference is observable in the hourly variations of the urine, for when the bicarbonate was taken before meals, the effect of the alkali passed off at the end of two hours, and the amount of acid passed in the succeeding three hours was nearly equal to what was passed on the day no medicine was taken; whilst when the salt was taken after meals, the urine remained alkaline up to the end of four hours after the dose was taken, and no recovery of acidity was noticeable.”

The explanation of these facts is found in the circumstance that the bicarbonates are really acid salts, and, if decomposed in the urine, result in the formation of neutral carbonates and *acid* phosphate of sodium. In the intervals of digestion, the reaction of the gastric mucous membrane being neutral or alkaline, they pass unchanged into the blood, and produce the above results. On the other hand, when these salts are taken during digestion, the acid contents of the stomach decompose them; carbonic acid is liberated, which escapes by the mouth, whilst the alkaline bases pass into the circulation and render the urine alkaline.

Of course there are many ways in which these ends may be attained, but the following recipes may be given as samples of mixtures which considerable experience enables me to endorse:—

R.—Tinct. aconiti rad. gtt. xvj.
Potassii bromid. ℥viij.
Potassii acetat. ℥ss.
Infus. pareiræ brav. f℥viij. M.

Sig.—Tablespoonful in water every two hours.

R.—Tinct. veratri viridis, gtt. viij.
Potassii bromidi,
Sodii bicarbonat. āā ℥viij.
Liq. potass. citrat. f℥viij. M.

Sig.—Tablespoonful in water every two hours.

¹ *Lancet*, Nov. 9, 1878.

For the same purpose, and at the same stage of the disease, a powder of tartar emetic and bitartrate of potassium has been found of great use, as has also the addition, to either of the above mixtures, of half a fluidrachm of the tincture of belladonna.¹

Instructions should next be given as to the best method of retaining such dressings as will serve to collect and absorb the discharge. The use of the India-rubber bags sold for this purpose, the tying of strings or tapes around

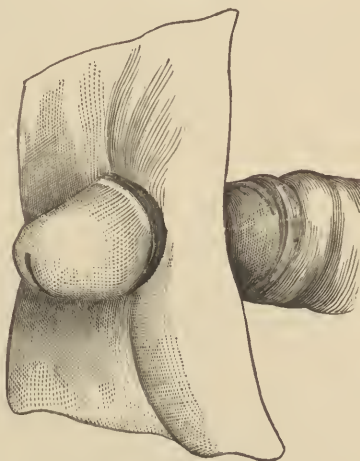
Fig. 319.



Dressing of absorbent cotton applied to glans penis.

the body of the penis, and the employment of any warm or cumbersome dressing are decidedly hurtful. Either by preventing evaporation, and thus keeping the penis bathed in a warm, moist atmosphere, or, as it were, poulticed, or else by mechanically interfering with the venous current and exciting erections, they often seem decidedly to aggravate the disease. If the foreskin quite covers the glans penis, the very best dressing consists of a little morsel of absorbent cotton placed over the meatus, and retained within the preputial orifice (Fig. 319). If it nearly covers the glans, but does not extend to the meatus, a small aperture should be cut in the centre of a piece of patent lint or old linen, $2\frac{1}{2}$ to 3 inches square; this should be stretched gently with the fingers until just large enough to slip over the head of the penis, and back of the corona (Fig. 320). The ends should then be turned forward, and the foreskin brought in the same direction, when it will serve to hold the lint

Fig. 320.



Application of lint-dressing to glans penis.

¹ At this stage of gonorrhœa, the late Dr. John Neill, of Philadelphia, was in the habit of administering the following powder:—

R.—Potass. bitart. ℥iv.
Potass. nitrat. ℥iij.
Antimon. et potass. tart. gr. j.

M. ft. chart. no. xij.

Sig.—One powder in water three times daily.

Mr. Reginald Harrison (Lectures on the Surgical Disorders of the Urinary Organs) believes that alkalies are not indicated in acute cystitis, and says that "the urine is less irritating in its normal acid condition."

or linen in place (Fig. 321.). If the glans penis be entirely uncovered, it will be necessary to support the dressing in some other manner. An excellent

Fig. 321.



Lint dressing applied to glans penis: the prepuce brought down to hold the lint in position.

plan, then, is to take the foot of an old stocking, or a bag of old muslin made large enough to hold the organ comfortably, and pin it to the front of the under-shirt.

In one or another of these ways, the linen and the surrounding parts of the patient may be protected from the discharge, while, at the same time, no additional element of irritation is added to the case.

The foregoing directions all pertain to the first visit of the patient. Having told him of the importance of rest, indicated his proper diet, prescribed a diuretic mixture, and explained to him the mode of dressing the organ, it only remains to watch the progress of events, for which purpose it is well to ask him to call on you every day for three or four days. If the case belong to the third (irritative or abortive) class, all the symptoms will subside in that time; if to the second (subacute or catarrhal), the discharge will become more profuse, but no marked subjective symptoms will develop; if to the first (acute inflammatory), the phenomena already described will make their appearance, with an intensity proportionate chiefly to the less or greater strictness with which the directions given have been observed. In the first case (irritative gonorrhœa), no further treatment is required; in the second (catarrhal gonorrhœa), we may at once begin with the use of such injections as will be hereafter described as appropriate to the declining stage of inflammatory urethritis; but if we are dealing with a case of the acute, inflammatory variety, we must continue to watch for and treat the symptoms.

TREATMENT OF ARDOR URINÆ.—For the relief of the *ardor urinæ* and tendency to frequent urination, the prescriptions already given are very useful, and should be persevered in, or given in larger doses and more frequently. In addition, the patient may be instructed to immerse the penis in hot water during each urination; the extraordinary relief which this sometimes gives is probably due to the equalization of the blood-supply caused by it, the temporary distension of the superficial vessels relieving, to a certain extent, the congested and swollen mucous membrane, and thereby diminishing the resistance to the passage of the stream of urine, and the friction between it and the sensitive walls of the urethra. The hot-water bath may also serve to overcome spasm of the urethral muscles, which often adds to the sufferings of the patient. When the scalding is very severe and persistent, hot demulcent injections given before urination, after gently “stripping” the urethra, may be ventured upon, but with caution, a good general rule at this stage being to avoid the use of these remedies. An infusion of sassafras pith, or of gum acacia, or of flaxseed, may be used after being strained and warmed, and if it gives relief and is followed by no symptoms of bladder trouble, may be persisted in. In other cases it will be found of advantage to wrap the entire organ in lint, soaked in lead-water and laudanum; or better still in the following lotion:—

R.—Tinct. aconiti rad.,
 Tinct. opii,
 Alcohol. āā f℥j.
 Liq. plumbi subacet. dil. f℥ij. M.
 Sig.—For external use.

Irrigation, or the use of dry cold by means of the India-rubber coil, is occasionally of advantage in moderating the intensity of inflammation at this period, and consequently in lessening the severity of the scalding.

TREATMENT OF CHORDEE.—In the treatment of *chordee*, attention must be paid to the following points, the first of which is the most important as a prophylactic measure: Before going to bed the bowels should invariably be evacuated, the presence of feces in the rectum contributing largely to the production of erections; to secure a movement at this time, it may be necessary to give a saline laxative during the afternoon or early in the evening, or to use an enema of soapsuds, but in any event it should be attended to. The bedroom must be cool and well ventilated, the mattress hard, and the bed-clothing light.

No late meals should be taken, and any tendency of the thoughts towards sexual matters should be resolutely combated. Soaking the penis in warm water, or the use of a prolonged warm sitz-bath, has been recommended, but does not seem philosophical, and in practice has not proved useful in my cases.

The medicinal treatment of *chordee* has embraced a great variety of remedies, of which none is at the present time generally recognized as of pre-eminent value. *Opium* in the form of suppositories, used at bedtime, is very efficacious, but not without its disadvantages, the constipation induced by it being prejudicial. It may be necessary to employ it, however, in which case the following formula may be used:—

R.—Pulv. opii, gr. vj.
 Pulv. camphoræ, gr. xvij.
 Ol. theobromæ, q. s.
 M. et ft. suppositoria no. vj.
 Sig.—Use one at bedtime.

Camphor may be given internally in doses of a fluidrachm of the tincture, or in the form of the monobromide, in from three- to five-grain doses. *Lupulin* in fifteen- to twenty-grain doses, and *gelsemium* in the dose of ten minims of the fluid extract, repeated every time the patient wakes with *chordee*, have in my experience been extremely useful. None of these remedies are, however, so certain in their effects as is *bromide of potassium*, which seems to have fallen into undeserved disrepute. Its employment as an alkali, as an arterial sedative, and as an anaphrodisiac, is especially indicated in the early stages of gonorrhœa, and should never be neglected, even when the symptom of *chordee* is absent. When that complication exists, the dose of bromide should be increased until decided drowsiness is produced, and it should be given at intervals during the day, with a double dose, combined with ten or fifteen drops of tincture of belladonna, at bedtime, and repeated if the patient awakes during the night with *chordee*. Under this treatment, pushed vigorously, the patient will rarely have any erections, painful or otherwise.

If, however, in spite of the free use of bromides, the employment of camphor and opium suppositories, and attention to the hygienic rules laid down, the *chordee* is persistent and very painful, it is well to adopt more active measures for its repression, not only to free the patient from pain, but because each recurrence of *chordee* aggravates the tendency to inflammation, and,

probably, increases the liability to subsequent stricture. In such cases nothing is so effectual as the free abstraction of blood from the perineum by means of leeches. From a healthy adult, eight or ten ounces should be taken, and for the next day or two he should occupy a strictly recumbent position with the hips elevated. He will usually be found at this time much more amenable to reason as regards the necessity for rest. Among the lower classes, it is well to caution patients against the practice of "breaking" a chordee, by which is meant placing the penis on a hard substance and striking it a blow with the clenched hand. This has the effect of causing the erection to disappear, but also of rupturing the trabeculae of the erectile tissue and the walls of the congested vessels, and of tearing or breaking up the new deposit which gives rise to the chordee. It is almost always followed by traumatic stricture, and, it is needless to say, is not a justifiable procedure. Upon the occurrence of chordee it is best to urinate, to walk around the room for a few moments, and then to go to bed, lying on the side. The practice of placing the organ on the marble slab of a washstand or on some other cold surface is objectionable, because, when reaction occurs, and is increased by the warmth of the bed, other much more violent erections are apt to follow.

M. Glaudot, following Dr. Scaenzio, recommends as preferable to all other resources in troublesome chordee, the hypodermic injection into the perineum of from one-fourth to one-fifth of a grain of morphia. This should be given just before the patient goes to bed, and after being used on four or five successive nights, may be stopped with a strong probability that the chordee will not return. M. Glaudot thinks that the good effects of the morphia thus used, are due entirely to its local action, as no narcotism, not even sleepiness, was produced in any of his cases.¹ Hill recommends thirty grain doses of chloral. Diday orders lupulin in half drachm doses mixed with an equal quantity of sugar, and in obstinate cases advises that a small pad of cotton soaked in chloroform should be applied to the area of greatest pain for several minutes. I have used ipecacuanha in small, nauseating doses, in cases in which other remedies had failed, but without much success.

More recently Cambrillard has recommended the following injection for chordee:—

Bromide of potassium, 6 parts.
Tincture of opium, 2 parts.
Purified glycerine, 10 parts.
Distilled water, 150 parts.

To be used four times daily, and retained in the urethra from two to three minutes each time.

Mauriac uses:—

Syrup of digitalis, 50 grammes.
Syrup of morphia, 50 grammes.
Bromide of potassium, 20 grammes.

Tablespoonful each evening, in a cupful of chamomile tea or other convenient vehicle. Suppositories of cacao butter each containing one gramme (15.4 grains) of chloral, may be used instead.²

This general plan of treatment should be persisted in while the symptoms are those of increasing inflammatory action, that is during the first eight or ten days. When they cease to grow more and more severe, or especially if they begin to subside, the first evidences of which will usually be diminution in the degree of ardor urinæ, it becomes proper to employ local medication, for which purpose injections are beyond all comparison the best agents.

SOLUBLE BOUGIES.—The use of *soluble bougies*, even in the earliest stages, is so strongly advocated by some writers, that it seems worth while to allude

¹ Cincinnati Lancet and Clinic, from Archives Médicales Belges.

² Saint Louis Clinical Record, March 1882, from Deutsche med. Zeitung.

to them here for the purpose of finally dismissing the subject. Iodoform, tannin, acetate of lead, carbolic acid, oil of eucalyptus, and many other drugs mixed with cacao butter, in proper proportions, have been recommended. I wrote not very long since that in my hands they had been so inferior to injections in their ability to control the discharge, had so often, even when carefully adapted to the acuteness of the symptoms, given rise to severe pain and troublesome chordee, and were besides so comparatively expensive, that I had entirely discarded them. Since then I have been led by reading several articles eulogistic of their merits,¹ to give them another limited trial, but with precisely similar results, and if I ever do return to them in the treatment of urethritis, it will be only on evidence furnished by reliable witnesses after observation of a large number of cases.

URETHRAL INJECTIONS IN EARLY STAGE.—To return to the use of injections:—When the surgeon has decided to begin their employment, because of the inflammation having passed its climax,² he should order for the patient a blunt-pointed, hard-rubber, urethral syringe large enough to hold three fluidrachms. The American Rubber Comb Co.'s syringe No. 0, and the Goodyear syringe No. 1 c, are those which I prefer. At this stage the disease, although often extending a few inches backward, has reached its greatest intensity at or near the fossa navicularis, a point easily reached by the nozzle of an ordinary syringe, which acts as a mechanical irritant and frequently serves to increase or perpetuate the inflammatory action. Glass syringes are so apt to be poorly made, unequal in calibre at different parts of the cylinder, or with the piston insufficiently wadded, that for these reasons, apart from the danger of breaking them, they should be avoided. The other apparatuses sold for this purpose, the India-rubber bulbs with long glass or rubber nozzles, the soft rubber tubes, etc., are even more objectionable.³

Having procured his syringe, the patient should be taught how to use it, and, although it gives a little more trouble, it is always well personally to inspect this procedure at least once. I have seen many cases in which it seemed impossible to obtain control over the disease and to limit the discharge, where the whole difficulty lay in the faulty use of the syringe. In using the injection, the patient should sit upon the edge of a hard chair, the buttocks projecting slightly over it, the feet separated, and the thighs relaxed. In this way all pressure or tension upon the perineal muscles is removed, and the injected fluid finds its way backwards to a sufficient depth. In those cases in which the disease is clearly localized anteriorly, or in which any injection reaching the prostatic urethra or the neck of the bladder,

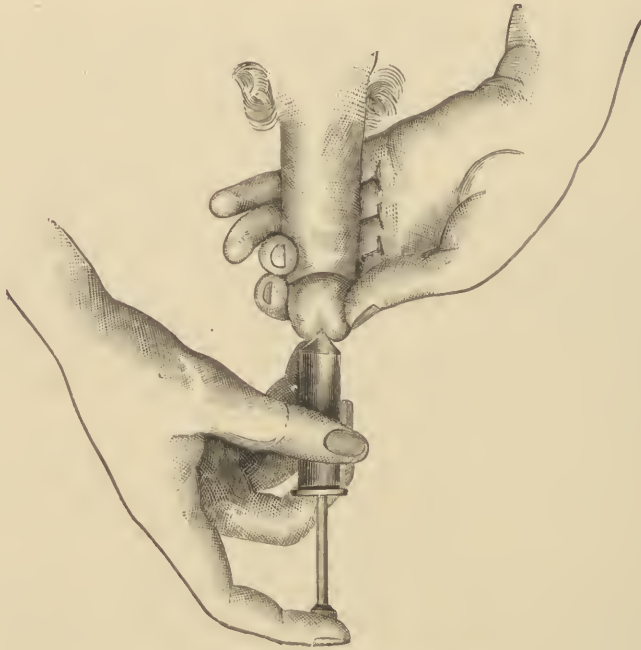
¹ Mr. W. Watson Cheyne (*British Medical Journal*, July 24, 1880) reports extraordinarily favorable results from a so-called "antiseptic treatment" of gonorrhœa, his special plan consisting in the introduction of soluble bougies made of iodoform, eucalyptus, and cacao butter. His results, however, do not appear to have been confirmed by other observers.

² Zeissl usually begins the use of injections during the acute stage, while the pains are very severe, and employs permanganate of potassium, two centigrammes in two ounces of distilled water. He cautions against the introduction of air, which he says gives rise to pain. (*Med. Times and Gazette*, Feb. 14, 1880.)

³ Mr. Balmanno Squire describes very minutely (*Annales de Dermatologie et de Syphiligraphie*, Avril 25, 1882) a new form of urethral syringe, which consists of an elliptical body made of rubber, with inflexible sides united by an interposed elastic strip which permits these sides to be accurately approximated. From the body a short rubber tube extends, into the end of which another small glass tube or nozzle is inserted. Mr. Squire claims that the theoretical requirements of a urethral syringe are all contained in this one, viz., possibility of manipulating with one hand; uniform movement without jumps or sudden variation of pressure; durability; portability; capacity just sufficient for the urethra; ability to retain liquid until used, so that a quantity sufficient for one injection may always be carried; and finally cheapness. As far as it is possible to judge from a description and a wood-cut, this syringe seems inferior to several similar devices made and sold in America.

gives rise to vesical irritability, the patient may sit upright, with a handkerchief or towel rolled up and placed just back of the scrotum, thus occluding the urethra at that point. The syringe having been nearly or quite filled, according to the depth to which it is thought necessary to throw the injection, is held between the thumb and middle finger of the right hand, the tip of the index finger resting on the end of the piston. The conical extremity of the syringe is then inserted from a quarter to half an inch within the meatus, which is held open for that purpose by the thumb and fingers of the left hand, and which is then drawn tightly around the syringe, the pressure being made laterally (Fig. 322), so as to narrow the aperture instead of broadening

Fig. 322.



Mode of administering a urethral injection.

it, as when it is compressed in an antero-posterior direction. If this is done properly, while the syringe is depressed so that the piston points about toward the umbilicus and is gently forced home, every drop of the liquid, to the amount of three fluidrachms, should be deposited within the urethra. If the margins of the meatus are not made closely to embrace the syringe, the injection will dribble out over the hand, and down upon the floor. One or two trials will usually overcome this difficulty, but if there is any trouble at first, it is safer to be convinced by actual observation that it has disappeared. The patient should then be told to use the injection in this manner after each urination, and to hold the injected fluid within the urethra for two or three minutes before suffering it to escape.

It may be laid down as a general rule, that any injection, even if it be water, which gives rise to more pain than might be described as a very slight smarting, is likely to do harm rather than good, and should be diluted or withdrawn.

If it be thought proper on account of uncontrollable ardor urinæ, or for any other reason, to begin injections during the early part of the stationary

period, it is well to use only hot water, or, as has been suggested, some hot mucilaginous infusion. When the ardor urinæ has fairly begun to subside, a sedative and slightly astringent injection may be employed, as for example:—

R.—Ext. opii, ʒj.

Liq. plumbi subacetat. dil. fʒiv. M.

Or

R.—Tinct. aconiti rad. fʒij.

Tinct. opii, fʒvj.

Mucilag. sassafras medullæ, fʒiij. M.

During this time, the original internal treatment should be continued, the alkaline diuretic being given in gradually decreasing quantities.

ANTI-BLENNORRHAGIC REMEDIES.—When the ardor urinæ and chordee have almost or quite disappeared, a change may be made with advantage in both the general and the local medication. It is at this stage that the employment of the so-called “anti-blennorrhagics” is indicated, the drugs which are usually included under this title being cubebs, copaiba, and sandal-wood oil.

Kava-kava has been used in urethritis, and it is claimed with some success. I have never used it. The formula recommended is,

Fluid extract of eucalyptus globulus, 60 parts.

Fluid extract of kava-kava, 20 parts.

Benzoic acid, 2 parts.

Powdered borax, 12 parts.

A teaspoonful three times daily.

According to Dupuy, kava-kava is, (1) a sialagogue, (2) a bitter tonic, (3) a gentle excitant of the nervous system, (4) a powerful diuretic, (5) a blennostatic. The effect of the resin of kava-kava in gonorrhœa, he considers exceedingly favorable; it relieves the pain and diminishes the discharge.¹ Mr. Leighton Kesteven, Colonial Medical Officer at Fiji, writes:² “The most marked and valuable property of kava, is its action upon the genito-urinary tracts. Chronic gleet I have found to yield readily to its effects, and in chronic cystitis it possesses an influence superior to any other remedy with which I am acquainted.” Cases are reported by Dr. Reed,³ in which a mixture of kava-kava and glycerine—one to three—in teaspoonful doses, seemed productive of benefit as an “abortive.” In the later stages, he thought it less beneficial.

Balsam of gurjun, or wood-oil, a resinous product, has been used as an anti-blennorrhagic. M. Vidal has experimented with it more extensively than any one else, and reports⁴ seventeen cases, in which the time of treatment varied from ten to twenty days. He used it in combination with simple syrup in the dose of one drachm, twice a day, taken at the beginning of meals. He writes, that “it is seldom necessary to exceed this dose, which is well tolerated, and of which the only effect on the intestinal tract is the production of one or two stools within two hours after the meal; the maximum dose was eight grammes. At first, a certain amount of nausea is produced, but it passes off very rapidly. A quarter of a glass of wine administered after the potion renders it better tolerated. One of the advantages of the medicine is, that there need be no change in the diet; wine was given during the whole treatment without producing any ill effects. Employed with the same care as copaiba, gurjun presents marked advantages. Its action is more rapid and certain, for it has frequently succeeded where copaiba has failed; it gives rise to no erythema; it gives no unpleasant odor to the breath or urine, which is one of the inconveniences of copaiba; locally, it succeeds well in vaginitis and balanitis; lastly, it costs less than copaiba.” More recently, M. Deval corroborates this from observations made by himself in M. Mauriac’s Clinique.

¹ Deutsche medicinische Wochenschrift, No. 1. 1881.

² Practitioner, March, 1882.

³ Therapeutic Gazette, January, 1882.

⁴ Journal de Médecine et de Chirurgie, Décembre, 1877.

Of the efficacy of *cubebs*, *copaiba*, and *oil of sandal-wood*, when administered at a proper time, there can now be no reasonable doubt, and any elaborate defence of their employment would be superfluous. Neither can there be much question as to their mode of action, which is manifestly through the urine. It seems essential that they should pass through the kidneys, since injections containing them have not been productive of very good results.¹ It is possible that their action consists rather in modifying the character of the urine, so as to render it unirritating, than in exerting any positively curative power.

However this may be, if they are given at this time, when the declining stage is beginning or is well established, and if they are used with due regard to the digestive powers and the idiosyncrasies of the patient, they will be of great benefit in the vast majority of cases.² If they produce anorexia, dyspepsia, or diarrhœa, it will be necessary to vary the mode of administration, and in a few instances no preparation can be found which will be tolerated by the stomach. This is especially true of *copaiba*, much less frequently so of *cubebs* and *sandal-wood oil*. In other exceptional cases they will cause irritation of the urinary passages as well, and must then of course be at once abandoned.

It has been stated that *copaiba* and *cubebs* are occasionally the cause of Bright's disease, but there is no authentic case on record of this character, and Zeissl denies its possibility. That they are capable, however, of inducing intense renal congestion, and even hæmaturia, seems beyond doubt. Bumstead and Taylor³ record a case of this character, and Hill and Cooper⁴ mention an instance in which the urine became of a coffee color on the second day of taking a *copaiba* mixture.

Gubler has apparently shown that the resin is the portion of *copaiba* eliminated in the urine, the volatile oil escaping by the skin and respiratory organs. Heidenreich has made the same observation as to the oil and the resin of *cubebs*.

Describing, however, a typical case of gonorrhœa, we may say that the following mixture will be of advantage at this stage, the bromide of potassium being continued in combination with the *cubebs*:—

¹ Mr. G. De G. Griffith thus alludes (Medical Press and Circular, March 21, 1877) to the local use of the balsam of *copaiba*. "As a topical remedy, I prefer an alkaline injection, having balsam suspended in it, or, sometimes even the pure balsam itself, and, in obstinate cases, I have found nothing better than the following plan:—

"Make your patient empty the bladder, then rest for a few moments; again have the bladder relieved of its contents; next pass down as full-sized a catheter—silver or gun-elastic—as your patient's urethra will admit, having previously charged the instrument with balsam, and smeared its surface with the same. When the eyes of the catheter are in the bladder withdraw your thumb or the leather-covered plug from the opening at the handle end of the instrument. In this way the balsam flows into the bladder, being released from the interior of the catheter which is then withdrawn. The patient again makes the attempt to pass water, the medicament will be expelled, and, in its transit, the urethra will be coated with it more or less completely. Indeed, I have often injected the balsam through the catheter into the bladder, and making the patient empty the latter as speedily as possible, have thus laved the entire urethra with the unctuous remedy. This plan I have found to be specially advantageous when balsam cannot be taken by the mouth, or when the discharge is chronic, or even very chronic, and also when some abrasion has taken place in the urethra, or when a bare, granular surface, or even ulceration, exists."

² Bumstead and Taylor write (op. cit. p. 65), that the curative effect of *copaiba* is much greater in the acute than in the chronic form of urethritis, and that it is rarely, if ever, productive of those complications which were once attributed to it. "In short, it would appear that *copaiba* can be administered with safety, and to much greater advantage in the acute stage of gonorrhœa, or at an early period of the stage of decline than afterward, and the same is true of *cubebs*. Still, when a case of this disease presents itself with marked inflammatory symptoms, it is usual to wait for a day or two until these have somewhat subdued—and I do not think that any time is thus lost."

³ Ibid. p. 69.

⁴ Op. cit. p. 512.

R.—Potass. bromidi, \mathfrak{Z} ss.
 Oleores. cubebæ, $\mathfrak{f}\mathfrak{Z}$ ss.
 Ol. sassafras, gtt. xij.
 Syr. acaciæ, $\mathfrak{f}\mathfrak{Z}$ ij.
 Aquæ, ad $\mathfrak{f}\mathfrak{Z}$ vj. M.

Sig.—Dessertspoonful every four hours.

At the same time, the injection may be changed to one containing an insoluble powder, which, by coating the urethra and partially protecting it from the urine, and also by its mechanical influence in constricting the dilated vessels and keeping the walls separated,¹ often serves greatly to reduce the discharge. The following formulæ are the best among a great many :—

R.—Bismuth. subnitrat. \mathfrak{Z} j.
 Glycerinæ, $\mathfrak{f}\mathfrak{Z}$ ij.
 Aquæ ros. ad $\mathfrak{f}\mathfrak{Z}$ iv. M.
 R.—Bismuth. subcarb. \mathfrak{Z} j.
 Mucilag. acaciæ, $\mathfrak{f}\mathfrak{Z}$ ss.
 Aquæ ros. $\mathfrak{f}\mathfrak{Z}$ iiiiss. M.
 R.—Pulv. zinci oxidi, \mathfrak{Z} j.
 Acid. tannic. \mathfrak{Q} j.
 Muc. acaciæ, $\mathfrak{f}\mathfrak{Z}$ ss.
 Aquæ ros. $\mathfrak{f}\mathfrak{Z}$ ijss. M.
 R.—Zinci sulphat. \mathfrak{Q} j.
 Plumbi acetat. \mathfrak{Z} ss.
 Tinet. opii,
 Tinet. catechu, āā $\mathfrak{f}\mathfrak{Z}$ ij.
 Aquæ, ad $\mathfrak{f}\mathfrak{Z}$ iv. M.
 R.—Zinci acetat.,
 Acidi tannici, āā \mathfrak{Q} j.
 Aquæ ros. $\mathfrak{f}\mathfrak{Z}$ iv. M.

After the cubeb mixture has been taken for two or three days, if the case is progressing favorably, copaiba may be substituted, or may be added to it, or, better still, capsules containing twenty minims each of oil of cubebs and oil of copaiba may be prescribed in doses of from two to four, three or four times daily.

In certain cases, where these preparations disagree or seem to lose their effect, it will be well to substitute sandal-wood oil, in doses of ten minims four times daily. This amount may be dropped upon a lump of sugar, which will absorb it, and may then be swallowed and washed down with a little water without difficulty, or it may be given in capsules. A commercial article is sometimes sold by druggists, which has not by any means the same therapeutic value as the genuine oil, being a decided irritant to both the genito-urinary and digestive tracts. It may be known by its turbidity or cloudiness, the pure oil being perfectly translucent and of a pale amber color.

ASTRINGENT INJECTIONS.—While using the injections containing insoluble sediments, the patient will often be unable accurately to estimate the character and amount of his discharge. After a time, therefore, about four or five days, it is well to substitute for them a watery solution of some simple astringent, preferably of sulphate of zinc,² beginning with about two grains

¹ Contact of the two surfaces of the urethra has long been recognized as a source of difficulty in gleet. Civiale, Milton, and others, endeavored to obviate it by introducing into the urethra and leaving there a long, narrow strip of lint, so as to keep its walls separated. I have never tried the plan, and should imagine that the danger of the lint slipping into the bladder and its irritating effect as a foreign body would be enough to outweigh any possible advantage.

² Jullien (op. cit. p. 72) speaks of the sulphate of zinc as that "précieux agent" which is "le modificateur par excellence de l'urèthre enflammé."

to the ounce, and combining it, if there be any lingering sensitiveness or tendency to scalding, with morphia or dilute hydrocyanic acid, as in the following prescriptions:—

- R.—Morphiæ sulphat. gr. j.
Zinci sulphat. gr. viij.
Aquæ ros. f℥iv. M.
- R.—Zinci sulphat. gr. viij.
Acid. hydrocyanic. dil. gtt. xij.
Aquæ ros. f℥iv. M.

In this, as in all other cases, if the injection proves to be painful, it should be diluted; if painless, and if it does not entirely control the discharge, it should be strengthened.

Now, under this treatment, in many instances, the discharge will disappear, and no further symptoms manifest themselves, unless, as often occurs, treatment is prematurely discontinued. The only safe rule to follow is to instruct the patient *gradually* to stop the use of injections and decrease the dose of medicines, omitting first the mid-day portions, then those of the morning, and last of all those taken just before going to bed; the whole process should extend over ten days. He should be cautioned also against frequent or vigorous “stripping” of the urethra for purposes of inspection.

TREATMENT OF PERSISTENT URETHRAL DISCHARGES.—If, in spite of the injections as above given, the discharge continues, recourse may be had to stronger solutions, the sensibility of the urethra being taken as the index. In this way five or six grains of zinc to the ounce will often effect a cure when weaker injections have failed. Or acetate of zinc, tannin, sulphate of copper, nitrate of silver, sulpho-carbolate of zinc, alum, tincture of catechu, hydrastin, and various other drugs, may be employed occasionally with advantage.

Surgeon-Major Wilson reports in the *Lancet*, for September, 1881, sixteen cases of gonorrhœa treated by injections of sulphurous acid and water, one part to fifteen. He says that under this treatment the purulent discharge becomes scanty on the first day, and on the third day is replaced by a thin gleet discharge, which also disappears in a few days. It is probable that his cases were of the “irritative” kind, and would have recovered as soon with any treatment not absolutely prejudicial. Dr. F. R. Fry¹ attributes Mr. Wilson’s success to the fact that he was dealing with “non-specific” urethritis, which is about equivalent to my own understanding of his results.

A remedy which has acquired considerable reputation as an injection is the *hydrastis canadensis*, or “golden seal,” the fluid extract being the preparation generally employed. It is used either alone or in combination with some astringent and sedative, as follows:—

- R.—Ext. hydrastis fld. f℥vj.
Zinci sulph. gr. xij.
Morphiæ sulph. gr. ij.
Mucilag. acaciæ, f℥j.
Aquæ, f℥iij. M.

Radha Nauth Roy, Assistant Surgeon, Aliquah, reports great success attending the use of injections of quinine in both the acute and chronic stages of gonorrhœa. He employs a solution of two grains in eight minims of dilute sulphuric acid and a fluid-ounce of rose-water, and says that it “acts like a charm,” the disease generally being cured within a week.² Experiments with this mode of treatment, made at the Venereal

¹ St. Louis Courier of Medicine, October, 1881.

² Indian Medical Gazette, May 1, 1876.

Dispensary of the Hospital of the University of Pennsylvania, have failed to confirm these statements.

A favorite prescription of the late Dr. Maury was :—

R.—Tinct. matico,
Tinct. catechu, āā f℥j.
Ext. opii, gr. xvj.
Plumbi acet. gr. xij.
Glycerinæ, f℥iv.
Aquæ ros. f℥vss. M.

Boracic acid, in the strength of five grains to the ounce of water, is strongly recommended as an injection by Dr. James G. Hyndman, of Cincinnati, and by others, who report unusual success following its employment in a number of cases. I am not able to confirm this opinion of the remedy, although I tried it in a number of cases at the time attention was first drawn to it.

The relative merits of these various remedies are unsettled, and an attempt to formulate them would require detailed description which would extend this article far beyond the prescribed limits. It may be assumed, however, that if, after careful attention to the rules already laid down, and the final trial of some of these supplementary remedies, a urethral discharge persists, it will fall under one or another of the divisions laid down on page 245, and will require corresponding treatment.

Diday, whose forty years of large experience entitle him to respectful attention, describes his treatment of gonorrhœa as follows, dividing the disease into four stages :¹—

First Stage.—Warmth during micturition; a drop of semi-transparent discharge at the meatus. Inject one drachm of a solution of nitrate of silver, one part in ninety, and retain for five minutes. In successful cases the discharge wholly disappears.

Second Stage.—Red, shiny meatus; hourly drop of yellow or greenish discharge; ardor urinæ; chordee. The secret of success in treating gonorrhœa lies in patient expectation throughout this stage, with the use of demulcent drinks, restricted diet, and rest.

Third Stage.—Reached on an average in five or six weeks, often not until two and a half or three months have elapsed. Meatus normal; almost no ardor urinæ; discharge less abundant and whitish. Copaiba, or cubebs and copaiba, and an astringent injection, are the remedies indicated.

Fourth Stage.—Usually the result of attempts at early suppression. Little or no pain; discharge small; disease unaffected by copaiba and cubebs; readily becomes worse under irritants. Here the main dependence should be placed upon injections, among which he prefers that of Ricord :—

R.—Zinci sulph. gr. viij.
Plumbi acetat. gr. xvj.
Tinct. opii,
Tinct. catechu, āā f℥ss.
Aquæ ros. ad f℥iv. M.
Sig.—Use three times daily.

TREATMENT OF URETHRAL CATARRH.—If the characteristics of what I have called urethral catarrh are present, a little attention to the general health, a few drops of the syrup of iodide of iron after meals, moderate exercise and fresh air, a free diet, with an occasional glass of claret or burgundy at meals, will usually be sufficient, without local treatment, to terminate the case. Perseverance in the use of astringent injections and in the introduction of bougies will sometimes hasten the cure, but quite as often seems to retard it. These constitute the majority of those chronic urethral cases which are

¹ Diday et Doyon, *Thérapeutique des Maladies Vénériennes*, etc., pp. 8–39. Paris, 1876.

often reported by patients as having been cured by homœopathic treatment, the negative character of which leaves free play to that *vis medicatrix naturæ*, which is really all that is required.

TREATMENT OF CHRONIC GONORRHOEA.—In other cases, particularly when the attack is the first one, the discharge persists, creamy or yellowish in appearance, associated with a few mild subjective symptoms, indicative of localized inflammation which proves to be easily warmed up into a state of activity; in other words, we have the condition which it will be convenient to designate as chronic gonorrhœa. To determine this beyond question, a bulbous bougie, three or four sizes smaller than the normal calibre of the urethra, should be gently inserted into the bladder, the surgeon noting as it goes in the exact situation of any point of unusual sensitiveness, and looking even more carefully for this or other similar points during its withdrawal. He must not be misled by the normal sensitiveness of the prostatic urethra, which almost invariably resents the introduction of an instrument for the first time. He should look at the shoulder of the bulb, and observe whether it brings out any discharge, and if so, notice its character. If the symptoms and appearances which have been described as characteristic of chronic gonorrhœa are present, it may be assumed that the sensitive spot corresponds to a small patch of granular urethritis to which it is necessary directly to apply appropriate remedies. For this purpose, the patient should be ordered a prostatic syringe of hard rubber, having a long curved nozzle with a bulbous tip. He should be instructed in what manner and to what depth

Fig. 323.



Prostatic syringe.

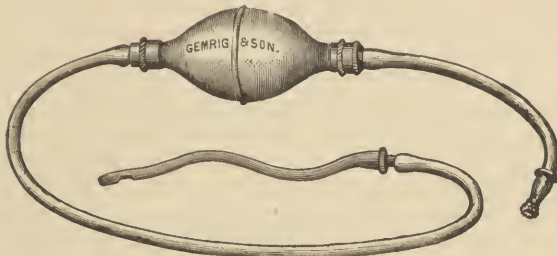
to insert this instrument, and the surgeon should himself administer the first two injections. For this it is well to use about one fluidrachm of a solution of nitrate of silver, of the strength of half a grain or a grain to the fluidounce of distilled water, or if this does not give rise to pain on the first injection, in still stronger solution. The discharge and pain may be increased for a short time after these injections, which should then be followed by gradually strengthened solutions of sulphate of zinc, tannin, or sulphate of copper, carried to the exact spot in the same manner. If the discharge diminishes, but does not disappear, the same process may be repeated, and this will almost invariably result in permanent cure.

It should never be forgotten that in certain cases, especially in those in which a history of frequent or prolonged attacks of gonorrhœa emphasizes the probability that some narrowing of the urethra exists, we may have the progress of the injection backwards cut off by spasmodic contraction of some of the circular muscular fibres surrounding the urethra, particularly that aggregation of those fibres which is called the *compressor urethræ* muscle, and which encircles the membranous portion of the canal, situated between the two layers of the triangular ligament. This, or a similar contraction, often so firm as absolutely to prevent the entrance of instruments however skilfully handled, will also in some cases, occurring as soon as the first drops of the injection reach the locality, effectually prevent the liquid from passing any

further, and will thus prevent it from coming in contact with the inflamed, or congested, or ulcerated surface which is the source of the discharge. In these cases the cure of the stricture, spasmodic or otherwise, by the use of full-sized sounds, is imperatively indicated, all other treatment being worse than useless.

Irrigation of the urethra with various medicated liquids has been recommended,¹ and is a most useful procedure in those few cases in which the foregoing treatment proves ineffectual. A moderate-sized, short, flexible, rubber catheter—preferably a “Nélaton”—with large bevelled eyelets, should be

Fig. 324.



Irrigating apparatus for gleet.

inserted nearly into the bladder, and then connected with a syringe, like the ordinary “Mattson” or “Davidson” syringe. A pint or more of the preferred solution, usually one of the astringents above mentioned, may then be passed through the urethra without withdrawing the catheter, the lotion finding its way between the instrument and the walls of the urethra, and making its exit at the meatus. In one or the other of these ways chronic gonorrhœa is always curable.

Durham² advocates irrigation in the treatment of urethritis, and employs a bulbous tube with apertures near the end, which is inserted beyond the inflamed part of the urethra. The injection is then pumped through by means of a Higginson’s syringe.³

Mr. Whitehead, surgeon to the Manchester Royal Infirmary, recommends⁴ that irrigation be employed in gonorrhœa to free the urethra from the inflammatory products, which obstinately and intimately adhere to the surface of the urethra, and protect the mucous membrane from the immediate influence of the remedies we endeavor to bring into action, either through the urine medicated by the administration of balsamic drugs, or by the more direct influence of anti-blennorrhagic injections. He describes and figures vulcanized and soft rubber catheters, having a deep spiral groove extending from tip to stem on their outer aspect. This groove is made with a depth double the capacity of the central tube, so that the facilities for the return of the injected fluids are greater than the requirements. The catheter ends in a large hollow bulb, perforated with two large apertures directed backwards. He regards the irrigation as a *preliminary* to treatment, and follows it by the injection of a medicated solution adapted to each particular case. I have had an instrument of this kind made, and have used it a few times, but am inclined to think that the irregularities of its surface, by increasing the pain of its introduction, are so great a disadvantage as to more than counterbalance any possible benefit.

Irrigation with *hot water* has been employed in gleet with apparent advantage.⁵ I

¹ The Prevention of Stricture, by R. Harrison, F.R.C.S. Lancet, May 15, 1880.

² Guy’s Hospital Reports, 1870.

³ See also Jullien, loc. cit., p. 89.

⁴ British Medical Journal, April 8, 1882.

⁵ Medical and Surgical Reporter, January 14, 1882.

have had no experience with this remedy as used in the gleet stage of gonorrhœa. It is unquestionably efficacious in the early stages.

The "cold-sound" (psychrophor), an instrument originally described by Dr. Winternitz, of Vienna, consists of a double-current catheter without eyes, the two canals communicating with each other near the point of the instrument, which can be introduced to the desired point in the urethra, and then attached by rubber tubing to a vessel containing fluid of the right temperature which is passed through the tube for a somewhat prolonged period. In a few cases of hyperæsthesia with persistent and frequent nocturnal emissions, I have found this instrument of great value. A few cases of chronic gonorrhœa also seemed benefited by it, but in these the effect may have been, as indeed it may in the others, merely a result of dilatation. My experience has not been extensive enough to justify a very positive opinion as to its usefulness. Keyes has found the psychrophor of use in cases of gleet discharge from relaxed urethras, without the presence of stricture. He employs iced water, allowing it to trickle through the catheter for about five minutes at each sitting.

In the chronic inflammations of the urethra, M. Mercier,¹ of Paris, recommends injections of nitrate of silver. If the spongy portion is affected, he uses a solution of one or two grains in an ounce of distilled water, making the injections in the ordinary way at intervals of from two to three days. In chronic prostatic urethritis he begins with these solutions, and gradually increases the strength to three or four grains to the ounce. He directs that the bladder shall always contain urine at the time of injection, so that the salt may be decomposed at once on its entrance into that organ, and calls attention to the fact that fluid deposited in the urethra anterior to the membranous portion will flow out of the meatus; while, on the other hand, fluid injected beyond this point invariably finds its way into the bladder.

Dr. Vajda² claims better results from continuous irrigation of the urethra than from any other method he has tried. He uses a perforated soft rubber catheter and a rubber water holder.

M. Pasqua³ recommends, as an injection, a solution of chloral of a strength of about five grains to the ounce of rose-water. "Two injections daily of a few minutes' duration have seemed to him sufficient. They produce at first a slight smarting and sensation of pricking, which in two or three minutes give place to a pleasant coolness. From the third or fourth day of the treatment, the desire to micturate and the erections become less painful and less frequent, the discharge diminishes, becomes more and more clear, and ceases altogether about the eighth or tenth day."

TREATMENT OF GLEET.—If now we find a patient with a true *gleet*, having had several previous attacks of gonorrhœa, or one which has been very protracted, and with dribbling after urination, etc., we should carefully examine his urethra with a bulbous bougie, when we shall probably find the condition described on p. 246, which is indicative of the presence of a sub-mucous deposit, or a "stricture of large calibre" or commencing stricture. The importance of remembering that, in every normal urethra, the bulb of the instrument will meet with some resistance as it passes under the posterior layer of the triangular ligament, is such, and a failure to recognize this fact has been so frequent a source of error in diagnosis and treatment, that it seems worthy of reiteration. For the proofs upon which the assertion rests, I must respectfully refer to the article already mentioned (p. 251).

Another source of error, already alluded to, is spasm of the muscular fibres occurring at some point along the urethra, and often imparting to the bougie the precise sensation felt in passing a stricture. The possible association of spasms of this character with strictures of large calibre situated anteriorly, should never be forgotten.

¹ Du Traitement des Inflammations des Organes Génito-urinaires. Paris, 1877.

² Schmidt's Jahrbücher, Bd. 188, No. 11.

³ Bulletin Générale de Thérapeutique.

On account of the importance of avoiding this error, I may be pardoned for quoting in this connection some remarks of the late Dr. T. B. Curtis, of Boston, the author of several valuable papers on genito-urinary diseases. He remarked¹ that "these disturbances [urethral and vesical spasms] are most common perhaps in persons suffering from urethral stricture; not only in cases of inveterate, narrow, deep-seated strictures, which every practitioner, however inexperienced and uninformed, is ready to recognize as such; but also, as shown by Verneuil, Guyon, Otis, J. Wm. White, and many others, in cases of tolerably wide anterior stricture of recent development. In such cases the most conspicuous symptom, or perhaps the only other symptom, complained of by the patient besides the urinary stammering and urethrisms, is an obstinate gleet. Not only acquired strictures of comparatively wide calibre, but even, as abundantly shown by Dr. Otis and others, congenital contractions of the meatus, more or less pronounced, and playing the part of strictures, behind which chronic urethritis, or gleet, has established itself, may be the origin and perpetuating cause of the nervous disturbances which are expressed in the form of chronic urethral spasm. Until the publication of Dr. Otis's views and experience in 1876, corroborated by the testimony of Dr. J. W. White in 1877, it had been almost universally agreed that spasm of the urethral sphincter was always temporary, and that the obstruction so caused was in all cases to be distinguished from that due to organic or permanent stricture by its short duration or by its intermittent character." These cases, however, demonstrated that a spasmodic contraction possessing all or nearly all the clinical characters of organic stricture, might be caused and perpetuated by a large stricture of the penile urethra, or even by contraction or stricture of the meatus. When spasm is suspected to exist, therefore, these latter conditions should be carefully searched for and removed, whereupon in every instance the spasm will promptly disappear.

It should not be forgotten that, in certain extremely exceptional instances, a stricture may be so easily distended as to permit of the uninterrupted entrance and withdrawal of a very large sized instrument, and yet so elastic as immediately to contract and become a source of discharge, vesical irritability, etc. In one such case, already mentioned, which Dr. D. Hayes Agnew saw with me, the urethra would admit a No. 32 steel sound with great ease, and yet a No. 18 or 20 bulbous instrument invariably disclosed a distinct abnormal contraction in the membranous urethra. In this case I performed urethrotomy with a bulbous urethrotome, and subsequently dilated with a Thompson's dilator to 36, securing a long interval of apparent health. The stricture, however, has returned and is again becoming troublesome. Such conditions, as I have said, are of great rarity, but their occasional occurrence cannot be denied, and they afford an additional argument in favor of the careful exploration of the urethra with a *bougie-à-boule* in all cases of obstinate gleet.

STRICTURES OF LARGE CALIBRE.—Having then determined the existence, situation and calibre, and exact character of an abnormal coarctation, the patient should be instructed to return in five or six days for treatment, being told, as in all cases after the first use of urethral instruments, that probably there will be some scalding when he next urinates, and that a few drops of blood may make their appearance.

At the end of that time, a conical steel sound about two numbers larger than the bulbous bougie originally used, and with the proper urethral curve—the arc of a circle having a radius of one and five-eighths inches—should be warmed, oiled, and very gently inserted into the bladder. It should be withdrawn far enough to relieve the desire to urinate, usually excited by its presence, and should then be allowed to remain *in situ* for from three to five minutes, provided that it does not give rise to continued pain. After five days or a week, according to the amount of subsequent irritation, a sound a size or two larger should be employed, and this should be continued until the normal calibre of the urethra is nearly or quite represented by the size of the instrument. This mode of treatment is safer, surer, and less painful than either urethrotomy

¹ Boston Medical and Surgical Journal, May 12, 1881.

or divulsion, which I reserve for excessively irritable or contractile strictures. Meanwhile astringent injections should be used, strong enough and often enough to cause the disappearance of the discharge. If employed too weak or too seldom, they will be almost useless.

During all this time, in the treatment of both chronic gonorrhœa and gleet, the diet should be moderate and simple, and alcoholic beverages, especially beer and champagne, should be strictly avoided. So also should sexual excitement, particularly if prolonged and ungratified. Anti-blemnorrhagics are sometimes useful adjuvants. There are many little details, not altogether unimportant, which want of space excludes; but I believe that a careful observance of the foregoing methods of treatment will, in the majority of cases, yield satisfactory results.

Some years ago, in cases of gonorrhœa, the following therapeutic measures were employed in the London Hospitals.¹ I am not aware how far time has modified them, but they are still of interest:—

Mr. Bryant, at Guy's Hospital, gave the tartrate of potassium in 20 or 30 grain doses three or four times daily, and found treatment by injections very unsatisfactory. He had, however, effected rapid cures by the injection every hour of a solution of alum or of tannin, 2 grains to the fluidounce.

Mr. Maunder, at the London Hospital, gave eopaiba during the onset and subsidence, and during the height of the disease used acetate of potassium—20 grains every four hours—with or without the eighth of a grain of tartar emetic and morphia. He also employed oft-repeated injections of sulphate of zinc.

Mr. Callender, at St. Bartholomew's, gave laxatives, diluents, warm baths and fomentations, opium or morphia suppositories, and, after the local inflammation had been allayed, ordered injections of sulphate of zinc, two grains to the ounce.

Mr. Wood, at King's College Hospital, prescribed at first low diet, saline aperients, diluents of liquor potassæ or bicarbonate of potassium, in camphor mixture or in an infusion of pareira, the frequent injection of glycerine and water. two fluidounces to eight, followed in the chronic stage by copaiba or powdered cubebs, frequent injections of sulphate of zinc, alum, etc., and at a still later period, by tincture of the chloride of iron and injections of the chloride of zinc.

Mr. Gascoven, at St. Mary's Hospital, in the very early stage, before much inflammation had set in, used weak astringent injections, frequently repeated; after the height of the disease was reached, he believed that copaiba was the most reliable remedy. After the violence of the attack had subsided, he again used weak injections, and gave cubebs and quinine. He found the treatment by salines and depletory remedies in the early stage of gonorrhœa not only useless, but positively injurious. He had scarcely ever known the so-called "abortive" treatment to succeed.

Mr. Barwell, at Charing Cross Hospital, avoided copaiba, which was apt to increase or lengthen the disease. In the case of a first attack with high inflammation, he used a purge, hot baths, and alkaline diuretics and aperients, followed by an injection of sulphate of zinc, two grains to the fluidounce. Second or subsequent attacks he treated with injections without any preliminary preparation. He also used tannin, three or four grains to the fluidounce of starch-water or syrup. In chronic gonorrhœa, turpentine, with black or cayenne pepper was useful, but the most certain treatment was the introduction every other day of a bougie smeared thickly with an ointment of from 3 to 10 grains of nitrate of silver to the ounce of lard.

Mr. Heath, at University College Hospital, used injections from the first. In the premonitory stage he believed in the efficacy of a strong lead lotion—*Liq. plumbi subacet. f℥j, aq. f℥vij*—and in the acute stage, warm water and a weak lead lotion, with bicarbonate of potassium internally, followed subsequently by an injection of sulphate of zinc. In gleet, if a distinctly diseased surface was discovered, the application of a strong solution of nitrate of silver gave the best results; if the disease were more general, astringent injections and the passage of a large-sized steel bougie were the

¹ *Lancet*, March 16, 23, 30, and April 13, 1867, pp. 331, 362, 411, 458.

remedies used. He believed that in many chronic cases the so-called gleet discharge was nothing more than the ordinary secretion of the mucous follicles of the urethra.

Mr. Hulke, at Middlesex Hospital, treated gonorrhœa almost exclusively by injections, first of acetate of lead, then of nitrate of silver, using weak injections frequently or strong ones at longer intervals. In old gleet he occasionally used cubebs or copabia, but more frequently tincture of the chloride of iron.

Mr. Watson, at King's College Hospital, used injections of half a fluidrachm of carbolic acid and one drachm of bicarbonate of potassium to a pint of water, every two hours, at the commencement, when the inflammation was not marked; subsequently he gave acetate of ammonium and tincture of hyoscyamus internally, and discontinued the injections, though at a still later period he returned to them.

TREATMENT OF COMPLICATIONS.

We may now proceed to consider, in the order in which they were described, the treatment of the various complications of gonorrhœa:—

BALANITIS usually requires for its treatment only perfect cleanliness and the use of some desiccant sedative powder, the one which I prefer consisting of opium and lycopodium (R. Pulv. opii, ʒj; lycopodii, ʒij.). Three or four times daily this should be dusted on the inflamed surface, previously washed and gently dried. Strips of dry lint inserted between the glans and foreskin, and changed whenever they become moist from the discharge, will often effect a cure.

Balano-posthitis, when accompanied with œdema of the prepuce, is best reduced by a lotion of lead-water and laudanum kept continuously applied. The dry dressing may be used with advantage after the swelling has subsided. I have seen good in both these cases follow from painting over the inflamed glans and the inner surface of the foreskin with a 30 or 40 grain solution of nitrate of silver.

PHIMOSIS may of course be relieved by circumcision, or by slitting open the foreskin along the dorsum, completing the operation at some later period; but both of these procedures are undesirable if it is possible to avoid them. In nearly every case, lead-water and laudanum externally, with sub-preputial injections of soap and water, followed first by clean water, and then by lead-water

Fig. 325.



Taylor's syringe for sub-preputial injections in cases of phimosis

and laudanum, will reduce the swelling, so that the glans may be uncovered. A convenient instrument for the administration of sub-preputial injections is that devised by Dr. R. W. Taylor, of New York, and shown in Fig. 325. If the phimosis be obstinate, it may sometimes be necessary to confine the patient to his bed for a day or two, enveloping the penis in the same lotion, keeping it in an elevated position, and encircling it with a narrow strip of bandage. If actual ulceration have occurred, healing will be promoted, after the inflammation has been reduced, by the use of an astringent injection beneath the prepuce, the old-fashioned combination of sulphate of zinc with laudanum and water being one of the best.

PARAPHIMOSIS, if seen at first while the preputial swelling is œdematous and not inflammatory in its character, should be immediately reduced.

The ordinary procedure, and one which usually suffices (Fig. 326), consists in oiling the parts, locking the index fingers of the two hands above and

Fig. 326.

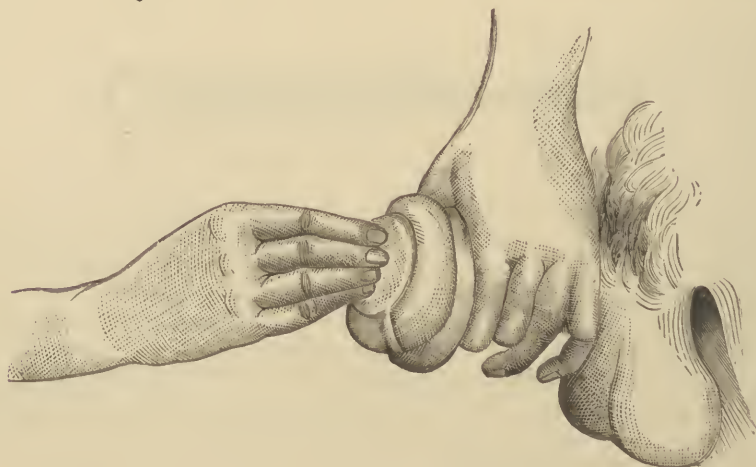


Reduction of paraphimosis by ordinary method.

behind the corona glandis, the middle fingers below and beneath it, and gradually compressing the glans itself with the thumbs, emptying its congested vessels and finally forcing it backward while the fingers bring forward the swollen foreskin. Or the body of the penis may be encircled with the thumb and index finger of one hand, while with the other, the glans is gradually compressed and pushed into the preputial orifice. (Fig. 327.) It must be remembered that, not only the glans, but also a ring of swollen mucous membrane is to be returned through that orifice. Sometimes by slightly elongating the parts instead of pressing them directly backward, their transverse diameter will be lessened, and their reduction will be facilitated. If the tip of the forefinger can be insinuated beneath the constricting ring, the subsequent treatment becomes easy.

When these means fail, or indeed, in preference to them in many cases, the method of Mr. Eddowes (Fig. 328) has in my hands been most satisfactory. It consists in wrapping the glans

Fig. 327.

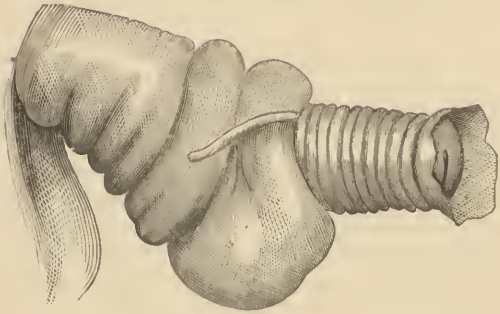


Reduction of paraphimosis by another method.

and prepuce with a slip of wet lint two inches wide, and extending a little in front of the glans, and then winding around the glans from before backward a piece of round elastic ligature.

By the time the corona is reached, the glans will be reduced in size, and it will be often possible to slip the end of a grooved director, the bend of a hair-pin, or the edge of the thin flat handle of a small spoon—such as a salt-spoon—beneath the constricting band. Then withdrawing the ligature rapidly, the shrivelled glans may be pushed backward, and the prepuce drawn forward to its natural position. Tape or a narrow bandage may be used instead of the gum cord, but is

Fig. 328.



Reduction of paraphimosis by Eddowes's method.

not as effective. If the chief obstacle to reduction be the amount of œdema, it is proper to evacuate the serum by several minute punctures with an exploring needle.

When the paraphimosis has been of longer duration, and an effusion of plastic lymph is present, more permanent compression may be required, and in that case the glans and foreskin should be “strapped” with pieces of adhesive plaster one quarter of an inch in width and six inches in length, the extremities beginning and ending on the body of the penis, the strips passing over the glans so as to cover all portions but the meatus; in twenty-four hours reduction usually becomes possible. If not, the dressing should be removed.

If all these means fail, we may divide the constriction on the dorsum of the penis by inserting beneath the prepuce a flattened sharp-pointed bistoury, and then turning its edge and cutting upward; or the stricture may be cut down upon from without inward, always remembering to look for it in the furrow which divides the mucous membrane from the integument, the first one *behind* the furrow of the cervix glandis.

FOLLICULAR ABSCESS often opens spontaneously into the urethra, and requires no surgical interference. When the skin becomes thinned and discolored over such a swelling, it is well to incise it freely. I have never seen any necessity for enucleating the wall of the abscess, or for treating it otherwise than would be proper for a similar condition elsewhere.

PERI-URETHRAL ABSCESS should be evacuated more promptly, as soon indeed as suppuration is established, as a spontaneous opening in these cases may be followed by urinary extravasation. In their earliest stages these abscesses may sometimes be aborted by the use of sedative lotions, with absolute rest in bed, moderate elevation of the organ, and free purgation. Leeches applied near them have never seemed to me to be of much benefit, and if applied directly over them usually aggravate the symptoms.

LYMPHANGITIS rarely requires any special treatment. Evaporating and sedative lotions and rest will usually relieve any pain which may be associated with it.

BUBO may be aborted by the use of pressure or iodine, or, if these fail, may

be poulticed and opened as in any case of glandular suppuration. It is never a serious affection.

COWPERITIS requires rest, elevation of the buttocks, leeches to the perineum, hot sitz-baths, poultices, and prompt evacuation if suppuration occur.

PROSTATITIS, PROSTATO-CYSTITIS, and CYSTITIS must all be treated in very much the same manner. They are among the most annoying of all the complications of gonorrhœa, and demand prompt and careful attention. Upon the first development of the early symptoms—frequent urination, vesical tenesmus, etc.—the patient should be placed at absolute rest in the recumbent position, with the hips elevated upon a hair pillow; his diet for a few days should be limited to skimmed milk, of which he may take any desired quantity; an alkaline diuretic mixture (see p. 258) should be freely administered; three-ounce enemata of hot water, or of hot starch-water containing a few drops of laudanum, should be given every two or three hours; six or eight ounces of blood may, with advantage, be taken by leeches from the perineum, which should afterward be covered with hot fomentations; and finally opium, combined with belladonna or hyoseyamus in suppositories, should be used at bedtime, and at intervals during the night if the calls to urinate are frequent.

I have not found that, in these cases, a moderate degree of constipation is particularly hurtful, and any rectal impaction of feces is prevented by the daily enemata already recommended, so that the objection commonly urged against suppositories, that by reason of their constipating effect they do harm, need not prevent their free employment. On the other hand, by securing rest, enabling the patient to maintain the recumbent position for a longer time continuously, and diminishing the spasm of the vesical and prostatic muscles, they contribute largely to the cure of the inflammation. Bromide of lithium, in five-grain doses every three hours, or citrate of caffèin, in three-grain doses, may be added to the diuretic mixture, if the urine remain scanty and high-colored.¹

All urethral injections should be immediately stopped, and the patient should be instructed to resist as long as possible the desire to urinate, and also the inclination to strain and bear down at the end of the act. By this method of treatment, which, although vigorous, is not unnecessarily so, it is possible to abort many cases of commencing prostatitis, and sometimes even to have the patient upon his feet again in two or three days. If, however, the symptoms do not subside entirely in that time, the continuance of the recumbent position and the other details of treatment must be urgently insisted upon, as the least imprudence is almost sure to bring on a relapse. In certain sub-acute cases, the leeches and poultices may be omitted, or even occasionally the enemata and suppositories, but rest, elevation of the pelvis, restricted diet, and an alkaline diuretic, are always essentials of treatment.

RETENTION OF URINE.—If *retention of urine* should occur as an additional complication, the surgeon should not hastily introduce an instrument, as by so doing, no matter how carefully, he would probably intensify all the inflammatory symptoms. I have rarely seen a case uncomplicated with old stricture in which the bladder could not be emptied—or, rather, induced to empty itself—by the following plan of treatment: Quiet the mental anxiety and distress, which are invariably present, by assuring the patient that he is in no danger, and will shortly be relieved. Insert beneath the skin of the

¹ Dr. Mracek (Allg. Wiener med. Wochenschr., No. 45, 1880) recommends chlorate of potassium, in divided doses of about four scruples daily, in cases of gonorrhœal cystitis.

perineum, by means of a hypodermic syringe, a quarter of a grain of morphia and $\frac{1}{20}$ grain of atropia, and repeat this in an hour if the retention persist. Place the patient in a hot bath, and keep him submerged to his chin until his urine begins to flow, or until he shows signs of syncope, in which case remove him and wrap him in blankets. If the heart's action remains irregular and alarms him, give a few drops of tincture of digitalis; if still unrelieved, place over the hypogastrium a large, mushy, hot hop poultice, covered with oiled silk, and renewed every two hours; give an enema of hot water and soapsuds, and after a time repeat the hot bath, or, if faintness is imminent, substitute a sitz-bath. By these means, patiently persisted in, catheterization can almost always be avoided.

If they fail, however, and the symptoms of retention and of distension of the bladder become serious, the urine should be drawn away with a Nélaton's catheter, using the greatest possible gentleness in its insertion. It must be understood that the evils of the gentle introduction of a soft catheter, even as often as twice daily, are less than those produced by the intense and almost continuous tenesmus which increases pelvic congestion, augments the prostatic and vesical inflammation, and causes almost unbearable suffering. Whenever, therefore, this condition is associated with dulness over the hypogastrium, and the hot bath, poultices, etc., fail to give relief, no further hesitation should be felt about resorting to catheterization. Of course, if a tight stricture be present, and there is difficulty in introducing a soft instrument, others must be tried, and occasionally external urethrotomy or perineal section may become necessary; but the description of these cases and of the operations for their relief does not properly belong to this Article, and will be found elsewhere.

PROSTATIC ABSCESS.—When, during an attack of acute prostatitis, the patient suddenly has rigors followed by increased fever and sweating, it becomes probable that suppuration has occurred in the gland. This does not involve any change in treatment, but digital examination per rectum should now be made once or twice daily. If the abscess opens into the urethra, as it usually does, no special treatment is necessary; if it points towards the rectum, however, or if, with unmistakable symptoms of suppuration, the abscess shows no disposition to point in either of these directions, it becomes necessary to evacuate it, as it is very desirable that it be prevented from burrowing between the layers of perineal fascia and so finding its way into the perineum. If this unfortunately occurs, an incision should be made in the median line until the pus cavity is reached.

In opening a prostatic abscess through the rectum, the finger should search for a prominent swelling on the surface of the prostate, less resistant and more fluctuating than the rest of the gland. A curved bistoury may then be passed along the finger and the abscess incised. No subsequent treatment is necessary, except the free use of hot water enemata.

M. Terrillon calls attention to the importance of feeling for the pulsation of the hemorrhoidal arteries in such cases, and of avoiding them in making the incision. A fenestrated rectal speculum may be employed with advantage in performing this operation, the patient having been previously etherized.

CHRONIC PROSTATITIS.—When prostatitis becomes chronic, the treatment is difficult and prolonged. That which has proved most beneficial in my hands may be summarized as follows: removal of stricture, contracted meatus, phimosis, or other predisposing cause; restricted but nutritious diet; avoidance of all liquors, except some form of light red wine; careful attention to the bowels, cold water enemata once a day being often of great service; daily cool

hip-baths, of a temperature and duration governed by the sensations of the patient, and persisted in as long as they are followed by relief of subjective symptoms; counter-irritation to the perineum, preferably by iodine; normal exercise of the genital functions. Cantherization of the prostatic urethra is unquestionably useful in many cases, but should be employed only after these other measures have failed. A few drops of a thirty- or forty-grain solution of nitrate of silver should be deposited in the prostatic urethra, and the immediate effect, which is a more or less marked inflammatory action, watched and controlled by rest and appropriate remedies. The operation may be repeated if no benefit results from the first application.

Ergot, in combination with iodide of potassium, has been recommended in cases of chronic prostatitis, as tending to restore the contractility of the prostate, and, at the same time, to favor absorption of the plastic material deposited in it. When other remedies have failed, the application, once a week for six weeks or two months, of a gentle faradic current to the prostatic urethra, by means of a urethral electrode, is often sufficient to remove all symptoms. I have notes of three cases in which it has seemed to be the efficient agent in producing a cure, although other remedies were employed at the same time. Zeissl recommends,¹ in chronic prostatitis consecutive to gonorrhœa, that a full-sized sound be passed daily for several days, and allowed to remain for four or five minutes. He adds: "It is always preferable for beginners to employ a metallic catheter rather than a sound, as it is a source of great satisfaction to them to see the urine flow from the bladder, and not remain in painful doubt as to whether the instrument is actually in the bladder or has made a false passage."

EPIDIDYMITIS, at its onset, when there is a little thickening found at the posterior edge of the testicle, a feeling of weight and dragging along the cord, etc., but no great swelling, should be treated as follows: Put the patient to bed in the recumbent position; elevate the scrotum above the level of the thighs by means of a folded towel laid beneath it, or by a handkerchief, folded triangularly, and placed with the base beneath the scrotum, the apex and extremities being brought up and fastened to another going around the waist or pinned to the underclothes (the seroto-lumbar triangle of Mayor's handkerchief dressings). Apply directly over the painful testicle a piece of patent lint, soaked in the following lotion, with which it should be kept continually wet:—

R.—Tinct. aconiti rad.,
Tinct. opii, āā f℥j.
Liq. plumbi subacet.,
Aque, āā f℥ij. M.

Shave the hair from the groin on the affected side, and take about six ounces of blood, by means of leeches, along the line of the cord. Administer a half-bottle of the effervescing citrate of magnesium, place the patient on restricted diet, stop all urethral treatment, give him a drop of tincture of aconite and five grains of bromide of potassium every two hours, or more frequently if there be any febrile reaction, and then watch the case. Almost always—eight times out of ten, at least—this treatment at an early stage will prevent any further manifestations; the symptoms will subside, and in two or three days the patient may be permitted to walk around, keeping the testicle still enveloped in the lotion and well supported by a suspensory.

In the remaining cases swelling continues, the epididymis becomes larger, and the tunica vaginalis becomes distended with fluid. Prompt action will still serve to cut short the disease. In such a condition the scrotum of the inflamed side should be made tense by grasping it with the left hand, while

¹ Medical Times and Gazette, February 21, 1880.

with a small sharp-pointed bistoury, dipped into carbolized oil, three or four punctures are rapidly made to the depth of from a quarter to half an inch. A few drops of serum will usually spurt out, sometimes a considerable quantity. In either event almost immediate relief from pain is experienced by the patient, and a continuance of the previous treatment will result in rapid cure. I have never seen unpleasant consequences of any description follow this plan of treatment, although it is said in one instance to have caused profuse hemorrhage. The method of puncturing the tunica albuginea, has, however, in a number of cases, been the cause of hernia of the tubuli seminiferi, and occasionally of destruction of the organ.

When the swelling, either in spite of treatment or in its absence, has progressed to a considerable extent and the testicle presents a large solid mass, the pain having become dull and aching, and only severe upon motion or in walking, great relief may be obtained by the application of compression.

For *strapping a testicle*, the scrotum should be shaved, the testicle drawn down as far as possible, and a strip of adhesive plaster about half an inch in

Fig. 329.

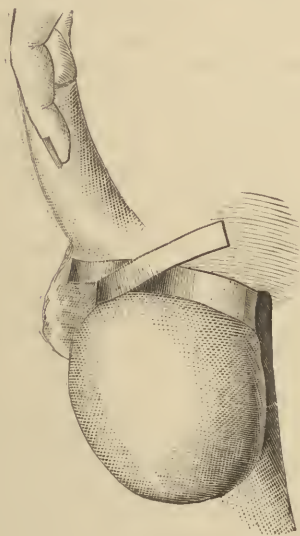
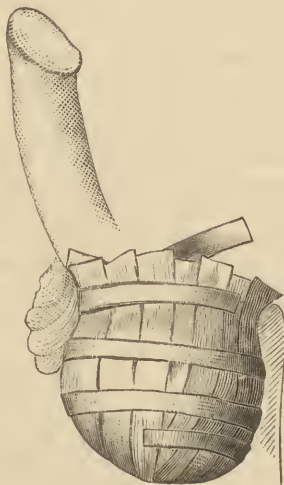


Fig. 330.



Strapping a testicle: application of the initial strap.

Testicle strapped.

width made to encircle it, so as to retain it in that position in the form of a tense tumor, pear-shaped and purplish in color (Fig. 329). This is then tightly covered in with successive strips of plaster (Fig. 330), placed first circularly until the greatest circumference of the tumor is reached and they refuse to adapt themselves neatly to the surface, and then longitudinally so as to cover in the lower segment completely. The testicle may then be placed in a suspensory bandage, and in most cases the patient is able to go about with little or no pain. The dressing should be replaced every day or two, as it will loosen as the swelling disappears. An ointment of belladonna and iodoform may then be applied upon a piece of lint worn beneath the suspensory.

The cases of trouble of various kinds, of failure to produce good results, of increased inflammation, etc., which have been reported to follow this

dressing, have, I believe, been due either to its improper and uneven application, or to its employment at too early a stage of the affection. I have now used it in so large a number of cases that I am enabled to speak of it with the utmost confidence as giving speedy, harmless, and almost invariable relief when neatly applied at the proper stage of the disease.

Of the very many other remedies which have been recommended in the treatment of epididymitis, I may mention the tobacco-poultice, a dressing made of fine cut tobacco and flaxseed meal mixed with hot water and laudanum, as of use in those cases in which cold applications cannot be borne. I must allude also to the benefit derived from the hypodermic injection of morphia in quantity sufficient to control the pain. In those exceptional cases in which this has become necessary in my hands, it has really seemed to have, to a certain extent, the positive curative action which has been claimed for it, the acute pain not returning even after the effect of the narcotic had worn off.

Lint soaked in a solution of nitrate of silver, one part to one hundred of water (Marc Girard); collodion as a means of compression (Bonnafont); ether applied on a piece of lint, and allowed to evaporate (Assadorian); friction with an ointment of antimony (Michel); injection of nitrate of silver into prostatic urethra (Boeck); iodoform ointment (Alvarez); puncture of the tunica vaginalis (Velpeau); puncture of the tunica albuginea and of the testicle itself (Vidal and Henry Smith); poultices of digitalis leaves (Besnier); pulsatilla, one drop of mother tincture every one or two hours (Piffard and Fox); ice applied in bladders (Diday); injection of morphia into tunica vaginalis, followed by strapping (Warren); oleate of mercury and morphia (Marshall); hypodermics of morphia alone (Milton); immersion in hot water followed by cold douche (Lloyd); nitrate of silver, 15 grains to the ounce (Jordan), are some of the measures recommended in this affection and enumerated by Bumstead in an excellent *résumé* in the American Practitioner for March, 1878.

Prof. Thiry, of Brussels, advocates¹ the use, in epididymitis, of strips of muslin covered with starch paste, and recommends their employment at the height of the acute stage, provided the general febrile disturbance has subsided.

An ointment of a drachm of iodoform to the ounce of vaseline is recommended in acute epididymitis by Dr. Sabadini, of Constantinople, and by Dr. Bourdeaux.²

The induration of the epididymis which remains after all inflammatory action has disappeared is usually permanent, and is not much affected by treatment. It may, however, diminish under the use of belladonna and mercurial ointment, and the internal administration of iodine and a mercurial. In cases of double epididymitis followed by sterility, it is well to pursue this method of treatment for a long period, as the re-establishment of the spermatic canal to ever so slight a degree is then, of course, a matter of great importance.

GONORRHOEAL RHEUMATISM has always been, and still is, considered to be a peculiarly obstinate and intractable form of joint-trouble, and treatment is pronounced, by all authorities upon the subject, to be in the highest degree unsatisfactory. The persistence of the swelling and inflammation, in spite of treatment, is always alluded to by such writers, and, although no average time is mentioned, it is evident that, in their experience, the disease has been a protracted one. I believe that it will necessarily be more or less so under any circumstances, but after a trial of all the various methods, local and general, which have from time to time been recommended, I am convinced that the results attained by adopting the following therapeutic measures are far superior to those following any other plan of treatment:—

¹ Presse Médicale Belge, 1877.

² Archives Méd. Belges.

On the occurrence of joint-symptoms, place the patient immediately at rest, and limit the movements of the diseased articulation, which should first be freely painted with iodine, then enveloped in a layer of cotton wadding, and, finally, confined by means of a splint. Purge briskly with a saline cathartic, and after its action has ceased, place the patient at once upon full—almost heroic—doses of quinia and small—anti-plastic—doses of some mercurial, preferably the protiodide of mercury. The use of these latter remedies constitutes the essential element of this particular plan of treatment. The quinine should be given in ten-grain powders three or four times daily, or oftener, if the symptoms of cinchonism are not marked, and should be pushed to the fullest degree consistent with safety. The mercurial should be administered in doses of a quarter or a third of a grain four times daily, until the gums and posterior molars become slightly sensitive, when the dose may be somewhat reduced. At first, a hypodermic injection of a quarter of a grain of morphia may be given at bedtime, but this will not be necessary for more than a few days. The splint should be removed daily, and, after the first three or four days, gentle motion should be made in the joint, especially if it be the wrist, after which it should be painted with iodine and immobilized again. If the case is unusually obstinate, leeches around the joint may be required. The diet should be generous, and great attention must be paid to the condition of the digestive tract. Urethral treatment, if mild in character and not involving instrumental interference, may go on uninterruptedly, but I have found it better to avoid the passage of bougies, at least during the acute stage of the rheumatism. The disappearance of the swelling may be hastened by “strapping” the joint with adhesive plaster, something after the fashion of its use in epididymitis. This should not be done, however, until after the acute symptoms have subsided.

I now have notes of nine cases treated in this manner, the last six having been recorded with considerable detail, as I had become convinced of the great superiority of this treatment over all other methods with which I had had any experience. The average time required for the permanent relief of pain has been about one week, and in every case but one the functions of the joint have been partially re-established by the end of the second week, in a few cases almost completely so. I hardly hope to maintain this degree of success with a very large number of cases, but believe it to be so much better than that afforded by the salicylates, by iodide of potassium and colchicum, by blistering of the joint, etc., all of which methods I have repeatedly tried, that I shall certainly continue its employment, and now venture respectfully to recommend it to the profession.

According to Dr. Cameron,¹ “treatment produces little or no effect; the disease, when severe, is always very chronic, and marked throughout by a disposition to occasional amendments, followed by disappointing relapses. It is not surely assuming too much to say that the articular affection is probably excited by the absorption into the system of some form of septic poison.” The same writer narrates two cases of multiple abscesses with well-developed pyæmic symptoms, one of them terminating fatally, following this variety of rheumatism.

Prof. Wm. H. Draper, of New York,² believes that the disease is a subacute rheumatism, and says he does not know “how he would distinguish it from an ordinary case of subacute rheumatism which was not associated with gonorrhœa.” He adds, however: “It is the most obstinate, the most rebellious to treatment, of all forms of rheumatism; the most discouraging. . . . Neither alkalies, nor salicylic acid, nor iodide of potassium, nor colchicum, nor any of the remedies that have been used in the treatment of rheumatism, seem to have any effect upon it”—thus, as it appears to

¹ Glasgow Medical Journal, February, 1881.

² Detroit Lancet, February, 1881.

me, himself noting a valuable diagnostic point between gonorrhœal and ordinary sub-acute rheumatism. Authorities might be multiplied very largely to prove that the affection is universally regarded as exceptionally intractable. Indeed, as far as I know, there is no difference of opinion as to this point.

Gosselin¹ recommends leeches, flexion of the joint, and hypodermic injection of morphia, but says that, under this treatment, the disease persists for from ninety to one hundred and twenty days, and frequently results in fibrinous exudation, destruction of the articular cartilages, and ankylosis.

GONORRHOËAL OPHTHALMIA is so closely allied to the preceding affection, and is so often associated with it, that it seems evident that the same general treatment would be likely to prove beneficial. I have had but two opportunities of testing this since adopting the method described above, and in neither of them was the result so conspicuously successful as to afford a basis for generalization, although I was inclined to think that the duration of the disease was somewhat shortened. In conjunction with the treatment by quinine and mercury, it would be proper in these cases to use warm collyria, to apply blisters or leeches to the temple, to keep the pupils dilated with atropia, and to use warm foot-baths, laxatives, sinapisms, and other revulsive measures.

CONJUNCTIVITIS, as a complication of gonorrhœa, is of so serious a nature, and the prognosis, in even the most favorable cases, is so grave that it is customary and advisable to call in the services of an oculist to share the responsibility. The general plan of treatment consists in placing the patient in a darkened room; hermetically sealing the sound eye to prevent infection; relieving tension, when chemosis is great, by free scarification of the conjunctiva; cauterization with the nitrate of silver; canthoplasty, to permit of the free escape of discharges; leeches to the temple; atropine; puncture of the anterior chamber when there is much increase of intraocular pressure; perfect cleanliness; and a general revulsive and antiphlogistic treatment.

Mr. Bader² recommends that an ointment, containing one grain of red oxide of mercury and one-fifth of a grain of sulphate of atropia to the drachm of vaseline, be used in case of gonorrhœal conjunctivitis. The eye should be first cleansed with tepid water, and the ointment then pushed freely beneath the upper and lower lids with a soft camel's-hair brush.

GONORRHOEA IN THE FEMALE.

Gonorrhœa in the female (Plate XV. Fig. 4) is neither as frequent, as limited in its situation, as protracted in its course, nor as serious in its results, as in the male. These facts, established by clinical observation, are due to the following causes: The anatomical arrangement of the genito-urinary organs in women, permits gonorrhœal inflammation to develop in the vulva, vagina, urethra, or uterus, which I have found to be involved with a frequency indicated by the order of mention. Vaginitis is, however, described by most writers as the most common of these varieties of gonorrhœa. The uterus is insensitive, not prone to inflammatory action from external irritants, and in a position where such irritants, especially when derived from sexual intercourse, are not retained in contact with it for any length of time. The delicate urethral mucous membrane is protected from frequent contamination by its sheltered position and its situation above the genital canal, fluids deposited in or flowing from the latter not necessarily coming in contact with it. The vulva and vagina are obviously much more exposed to irritating or traumatic

¹ Gazette des Hôpitaux, No. 108, 1877.

² British Medical Journal, November 13, 1880.

agencies, any one of which, whether a purulent secretion from the male urethra, the use of violence, inordinate masturbation, etc., is capable of exciting in these parts a mucous inflammation whose characters are always practically the same whatever its etiology, the distinction between "simple" and "gonorrhœal" vulvitis or vaginitis being a purely imaginary one.

Even here, however, inflammatory troubles are much less frequently met with than is urethritis in the male, because—

(1) The vulva and vagina are protected by a membrane, thick, non-absorbent, usually well lubricated by the natural secretions of the parts, and often rendered extremely insensitive by continual friction.

(2) There are to be found in men almost none of the chronic discharges which are so common in women, and which cause the majority of cases of masculine gonorrhœa.

(3) It is almost impossible for a man with an acute urethritis, that is in the most contagious stage of the disorder, to have connection, the pain produced by erection being in itself a sufficient preventive. This is not true of women to anything like the same extent, prostitutes especially often plying their trade in disregard of the comparatively moderate pain of even an acute vaginitis.

(4) The organs of the female participate less actively and less completely in the physiological congestion of coitus—a powerful predisposing cause of inflammation.¹

VULVITIS.

CAUSES.—Vulvitis may be produced in any of the ways mentioned, may be secondary to a vaginitis, may be due to worms, to the secretions of mucous patches, to uncleanness and the accumulation of sebaceous matter, to the application of fatty ointments which have become rancid and irritating, to masturbation, to criminal violence, or to any other traumatic or infective cause. It is sometimes seen to arise spontaneously in infants during dentition, and is said, by Dupuytren, who cites cases in proof, to be occasionally epidemic among very young children. In either of these cases, the characters of the inflammation are in all respects indistinguishable from those of a vulvitis caused by purulent infection, an important medico-legal point which should never be lost sight of when, in such instances, suspicion points towards any particular individual as a possible source of contagion.

Vulvitis produced by masturbation is said to affect chiefly the clitoris; vulvitis caused by attempts at rape, the lower portions of the labia and the fourchette. This distinction, if it be of any value, can only apply to cases seen upon the first development of the disease, as, at a later period, the portions of the vulva originally unaffected are almost certain to be involved.

SYMPTOMS.—However caused, vulvitis begins with an itching sensation and a feeling of heat and burning, soon followed by tumefaction of the parts, which are bathed in a secretion, at first muco-purulent, then thick, yellowish or greenish, acrid and offensive. If the parts be inspected at this time, a day or two after the onset of the disease, the labia will be found red, abraded, and excoriated; and the nymphæ sometimes swollen so as to occlude almost completely the entrance to the vagina. The parts are sensitive to pressure, and painful upon motion, so that in severe cases, the only position in which comfort can be obtained is upon the back with the knees widely separated. The vulva is often surrounded by an area of congestion which extends beyond

¹ See Jullien, *op. cit.*, p. 255.

the vulvo-femoral folds and may be seen for some distance down the thigh, and which in chronic cases often becomes of a purplish or dusky brown color, looking like the pigmentation following an old syphiloderm, for which it should not be mistaken. The passage of the urine across the inflamed surfaces gives rise to an intense burning, which may be mistaken for the ardor urinæ of urethritis, and is often quite as severe.

COMPLICATIONS.—*Bubo*.—The inguinal glands are apt to be enlarged and tender, and sometimes suppurate. *Bubo* is, however, also less common in the female than in the male, and when it does occur, is almost always associated with this form of gonorrhœa, or with a urethritis.

The *sebaceous* and *muciparous follicles*, underlying the vulvar mucous membrane, which extends into and lines them, are frequently involved in the inflammation which spreads by continuity into their cavities, occludes their mouths by exudation into the submucous tissue, and causes them to project above the surface of the vulva as little elevations, visible to the sight and sensible to the touch.

Vulvo-vaginal Abscess.—In other cases inflammation follows the ducts of Bartholin's glands, and excites suppuration or abscess in these bodies, which are compound tubular glands, situated one on either side of the entrance of the vagina, surrounded by a fibrous envelope, and during sexual orgasm pouring into the vagina, just anterior to the hymen, a milky, albuminous fluid. In acute cases of this complication—vulvo-vaginal abscess (Plate XVI. Fig. 4)—there are heat, pain, redness, and tenderness of the inflamed part; which signs, together with the peculiar pyriform swelling, serve to facilitate the recognition of the condition. In the early stages, the swelling can most readily be recognized by putting a finger in the vagina, and pressing outwards towards the ramus of the ischium. The abscess will sometimes evacuate itself spontaneously through the duct of the gland, or at the inner surface of the nymphæ; or the pus may work its way between the layers of the ischio-pubic fascia, and escape just within the labium majus; but its cure can usually be hastened by a prompt and free incision made through the mucous membrane at the inner and lower aspect of the tumor. Suppuration in these glands has a peculiar tendency to recur, and the accumulation of pus and the consequent swelling will often take place, after a first attack, without any marked symptoms of inflammation. Under these circumstances—particularly if pressure on the tumor does not cause the appearance of pus at the orifice of the duct—it is possible, in exceptional cases, to mistake the condition for a pudendal hernia, for a cyst, for a hydrocele of the round ligament, or for œdema of the cellular tissue of the labium. The differential points in the diagnosis of vulvo-vaginal abscess from the three first-mentioned affections may be contrasted as follows:—

CHRONIC VULVO-VAGINAL ABSCESS. ¹	PUDENDAL HERNIA.	CYST OF THE LABIUM.	HYDROCELE OF THE ROUND LIGAMENT.
History of previous inflammation.	Sudden appearance.	Slow, painless growth.	No previous inflammation.

¹ Abscess of the vulvo-vaginal gland, which is very common in consequence of venereal excess, especially during menstruation, is also met with as a complication of mucous patches. In this case the labium of one side is swollen, œdematous, and deformed by an enlargement situated at the inferior part of the vulva. Fluctuation is readily felt beneath the skin, distended by the purulent fluid, and by puncture a considerable quantity of pus mixed with blood is discharged. The mucous glands which are seated below the urethra, in the vestibule, may also be inflamed, and form a small cup-shaped ulcer about one and a half millimetres in diameter; its margin is usually formed of normal mucous membrane.

CHRONIC VULVO-VAGINAL ABSCESS.	PUDENDAL HERNIA.	CYST OF THE LABIUM.	HYDROCELE OF THE ROUND LIGAMENT.
Swelling pyriform; base downward; greatest swelling inward.	Shape very similar, but greatest projection outward.	More distinctly circumscribed; sometimes pedunculated.	General, diffused swelling.
Fluctuation.	Doughy or elastic.	Elastic.	Doughy.
Irreducible.	Reducible by pressure near ramus of ischium.	Irreducible.	Partially reducible.
No impulse on coughing.	Distinct impulse.	No impulse.	No impulse.
Dull on percussion.	Resonant if an enterocoele.	Dull.	Dull.
Most common in old prostitutes.	Seen at any age.	Seen at any age.	Seen oftenest in young persons.

(Edema of the vulva is usually symmetrical, and in every case in which I have observed it has either been a result of pregnancy or parturition, or of the presence of an abdominal tumor, or has accompanied a vulvitis, and was then of course easily recognized by the inflammatory symptoms.

Some interesting cases have been reported illustrating the possibility of contracting gonorrhœa from the pus secreted by abscesses of this character, which is squeezed out during intromission. In one instance no other disease of any kind was discoverable. It has been suggested also that these cases of chronic vulvo-vaginal abscess are those which not infrequently afford examples of the escape of certain individuals who have had connection with a woman known to have infected others at or about the same time. The abscess-cavity being emptied by the first person, those following him at short intervals are not exposed to contact with its irritating secretion, and consequently develop no disease.

Mucous Patches.—There is a form of vulvitis complicating mucous patches of the female genitals, which is due to contact with the labia of the oozing, offensive, puriform secretion of the syphilide. The condition is described by Cornil¹ as follows:—

“The internal surface of the labia minora is generally red, and the remains of the hymen are almost always swollen, and of a bright red color. The urethral and vaginal orifices are in a similar condition. The folds of mucous membrane forming the remains of the hymen and the upper part of the urethral opening are frequently the seat of red or pale, irregular elevations, resembling vegetations; these elevations are covered by very thick layers of the epidermis. The sebaceous glands of the labia minora are enlarged, and at their orifice is seen a small, opaque, white concretion, which may be forced out by pressure, measures about half a millimetre in length, and consists of epithelial cells. The vulvo-vaginal glands are frequently swollen, so that they are easily felt, attaining the size of a cherry-stone or more. By pressure there may be made to flow from their ducts a turbid, mucous fluid, which contains numerous pus corpuscles and filaments of mucus. When the inflammation is very intense, a few drops of this fluid are discharged from the duct, even in cases in which there is no abscess of the vulvo-vaginal gland; the discharge is due to a limited suppuration of the connective tissue surrounding the gland.”

Vaginitis.—The vulvitis which accompanies vaginitis in non-syphilitic patients often occasions small red erosions, round or oval in form, and upon

¹ Syphilis: Its Morbid Anatomy, Diagnosis, and Treatment, p. 151. Translated by J. H. C. Simes, M.D., and J. Wm. White, M.D. Philadelphia, 1882.

the surface of which a desquamation of the most superficial epithelium occurs. These erosions are frequently bright red in color, and measure from two to eight millimetres in diameter, are painful, vary from two to six in number, and are seated within the labia majora between their base and the hymen. They do not cause a thickening of the corium, and the connective tissue of the mucous membrane remains pliant and normal, which distinguishes them from mucous patches. These very superficial erosions are especially found in the fold between the hymen and nymphæ, while mucous patches are found upon the labia. "In the Lourcine Hospital there are frequent opportunities to study vulvitis in its most simple form in the children from Sainte Thérèse ward, in whom there is no accompanying vaginitis; the redness, discharge, inflammation of the sebaceous and mucous glands, and erosions are the same as with girls arrived at puberty. In children, where the hymen is generally intact, this membrane, during vulvitis, is very red and swollen."¹

Phlegmon.—In prostitutes of the lower class, vulvitis, neglected and allowed to spread unrestrained, or aggravated by continued coition, uncleanness, retention and decomposition of the discharge in the folds of the labia, etc., occasionally gives rise to a *phlegmonous inflammation* of the subcutaneous and submucous cellular tissue, erysipelatous in its character, accompanied by serious constitutional disturbance, and usually resulting in diffuse suppuration, or in the formation of multiple abscesses. Such cases are never seen except in hospital wards, and usually occur in confirmed drunkards, whose habitual condition of stupor or semi-consciousness renders them insensible to the approaches of the male, which would otherwise cause great pain.

In one such case which fell under my notice, it was subsequently discovered that eight men and boys had, within an hour or two, used the person of the already diseased but not unwilling patient for the gratification of their sexual desires.

Nymphomania.—In the early stages and less severe forms of vulvitis, even with better classes of patients, there is often seen an increase of erotic impulses, sometimes amounting even to *nymphomania*, and inducing the patient, if she be a loose woman, to disregard all advice as to abstinence from coition, until the progress of the disease renders the act so painful as practically to preclude its performance.

CHRONIC VULVITIS.—When the disease becomes chronic, the most frequent and most noticeable symptoms are enlargement of the nymphæ, a purplish discoloration of the parts, an increased mucous and sebaceous secretion, often offensive, and a tendency to pruritus, which, when marked, is very distressing.

VAGINITIS.

CAUSES.—Vaginitis has for its most frequent cause a purulent discharge from the male urethra. In other words, gonorrhœa in the female is usually due to a similar disease in the male. The explanation of this fact has already been given (pp. 223, 224). It may, however, result from violent or excessive copulation, from masturbation, from contusions, from inflamed hemorrhoids, or in various other ways.

Thomas reports two cases in which vaginitis, having all the characteristics which he believes to belong to a specific variety, was developed by the accidental contact of chromic acid with the vaginal walls.

¹ Cornil, op. cit., p. 152.

Females already affected with leucorrhœa sometimes develop a vaginitis after protracted exertion, and this is said to be particularly true of sewing girls who use the treadle of the sewing-machine for many hours daily. It may result from an extension upwards of a vulvitis, although the reverse is met with quite as often. Children and young girls are especially subject to inflammation of the vagina, which is sometimes found as a complication of dentition or of the eruptive fevers, and sometimes as a sequel of the first approaches of the male. In countries where early marriages are customary, it is not uncommon to hear of cases in which the husband has been wrongfully suspected of disease, on account of the occurrence of a "gonorrhœa" in the wife during the first few weeks of married life. Soon after puberty, the parts being small, the vulvo-vaginal outlet contracted, the mucous membrane tender, the orgasm and accompanying congestion very complete, the conditions are all favorable to the development of inflammatory troubles. It is for these reasons, as well as on account of their neglect of hygienic precautions, that young prostitutes are notoriously the most dangerous.

Dr. Matthews Duncan¹ describes diphtheritic, erysipelatous, ulcerous, and pustular forms of vaginitis. Exclusive of these varieties, he divides cases of vaginitis into two classes, (a) *local*, under which head he places those cases due to gonorrhœa, to violent sexual approaches, as in early marriage, to the introduction or use of pessaries, etc.; and (b) *constitutional*, in which, he says, there exists some predisposition, such as old age, alcoholism, lupus, diabetes, etc. The same writer, after considering the usual varieties of gonorrhœa in women, makes the following very judicious remarks upon the possible recognition of the cause in any given case of vaginitis:—

"Is it, in any special case, venereal or not venereal? You will, in practice, often be asked this question, and I advise you never to answer it explicitly. You cannot decide absolutely whether a case is venereal or not. At one time it was supposed that the discovery of trichomonads, or a leptothrix, or a vibrio, would decide whether it was venereal or not. But this is now given up. I have seen gonorrhœa which was certainly not venereal bear every character of the ordinary venereal disease. I do not say that there is no distinction, but only that the distinction cannot be made out by the practitioner so as to justify him, from his own inquiries into a case, in giving a decided opinion on the subject. Meantime, the distinctions of venereal gonorrhœa are simply marks of severity. It has been said that venereal gonorrhœa is infectious, while simple gonorrhœa is not; but I have seen every character that can be predicated of the one occur in the other, as I said before, including infection.

"What are the characters that make you suspect that a vaginitis is of venereal origin? It begins within a few days—generally two or three—of the infection; it is very severe, and runs an acute course; the secretion of pus is copious, beginning about the third day of the inflammation, and remaining copious for about a week or nine days. The vulva is generally affected, so that the woman has more or less difficulty in walking; and the vulva being affected, the inguinal glands are liable to be affected, and you may even have bubo. The urethra is affected, and also the bladder; there is liability to ovaritis and to perioophoritis; and there is the almost certain infection, not only by sexual intercourse, but by the matter touching any mucous surface, such as that of the eye."

Vaginitis, which is apt to be of a leucorrhœal character, sometimes occurs in the early stages of syphilis, as a result of the extension of inflammation from mucous patches seated upon the vulva, or of changes which take place in the os uteri. The neck of the uterus frequently undergoes certain alterations in the secondary stages of syphilis, which may be the medium of propagating inflammation to the vagina. According to Cornil:²—

"Quite frequently mucous patches, at first with an epithelial covering, afterwards eroded, appear upon the os uteri, one or two in number, or forming groups. The parts

¹ Medical Times and Gazette, June 26, 1880.

² Op. cit., p. 153.

of the os where the patches are situated lose their epithelium and are transformed into ulcers. Very often, when mucous patches have not been observed, there is a slight erosion of the orifice of the os, a muco-purulent catarrh of the neck, and a hypertrophy of the entire organ, the neck especially becoming large and hard. This inflammation, and this fibro-muscular hypertrophy of the neck, are certainly not always caused by syphilis. But if the neck of the uterus in young girls affected with simple vaginitis, who have never had children or miscarriages, is compared with that of girls of the same age who are suffering with syphilis, it is at once very evident that the syphilitic patients have the neck of the uterus enlarged and affected with a catarrhal inflammation; while it is small and normal in simple vaginitis. The only lesion observed in the latter is the redness of the vaginal mucous membrane continued over the os uteri. It may therefore be rationally concluded that the inflammation of the neck is sometimes directly due to syphilis, as are vulvitis and vaginitis, without necessarily the presence of mucous patches upon the neck."

SYMPTOMS AND COMPLICATIONS.—Vaginitis following purulent infection usually begins at the lower and posterior aspect of the canal. It is at first attended with a feeling of weight and fullness, sometimes referred to the rectum, and with a dry, glazed, congested appearance of the mucous membrane. Cases are described by Ricord and others, in which, through a considerable period, this condition, which then involves the larger portion of the vagina, obstinately persists, finally subsiding without the production of a drop of discharge. I have never met with this variety of gonorrhœa, and if it were not for the distinguished authority upon which it rests, would believe that a passive congestion, such as is often seen during pregnancy, or in patients with uterine or other abdominal tumors, had been mistaken for a vaginitis.

Usually after the lapse of a few hours a mucoid discharge appears, rapidly becomes purulent, and, when the disease involves an increasing extent of surface, as it generally does, is very profuse, soiling the posterior portion of the patient's linen, and trickling down her thighs and over her perineum, unless restrained by suitable dressings. The subjective symptoms, although not often as marked as in vulvitis, are occasionally very characteristic, and are due, in the first place, to the proximity of the bladder and rectum to the inflamed canal, and in the second, to the nervous connections of the region giving rise to certain reflex phenomena.

Under the first of these classes may be enumerated vesical irritability and tenesmus, aching or throbbing pelvic or hypogastric pain, hemorrhoids, dysenteric symptoms, prolapsus uteri, etc.; under the latter, sciatic, crural lumbar, and abdominal pains, which last symptom, when it is observed in hysterical women, and is associated, as it is then apt to be, with tympanitic distension and apparent tenderness of the abdomen, may lead to the erroneous diagnosis of *peritonitis*, a complication which actually occurs in a very small number of cases. Its absence may be ascertained by attention to the pulse and particularly to the temperature of the patient, and by powerfully attracting her attention away from herself while at the same time firm pressure is made upon the abdominal walls.

The same increase of *sexual desire* is found in these patients as in cases of vulvitis, but to a much less marked degree. On the other hand, however, coition is not usually attended with an equal amount of pain as when the vulva is involved, and it is more easy for the woman to conceal the fact that she is diseased; the temptation, therefore, either to yield to her impulses, or to avoid pecuniary loss by continuing her occupation, is at least equally great, and the enforcement of rest and of continence is quite as difficult.

Sometimes when the inflammation has been very intense and the discharge has been retained, extensive though superficial *ulceration* of the vagina

occurs, the pus becomes mingled with blood, the pain is considerably increased, and the disease assumes a very obstinate and rebellious form.

CHRONIC VAGINITIS.—In the chronic variety of vaginitis the presence of the discharge, thickening of the vaginal mucous membrane, and enlargement of its papillæ, are almost the only symptoms to be met with. Now and then a case is seen in which the inflammation has become strictly localized, a small patch of strawberry red granulations being found, analogous to those seen in the urethra in chronic gonorrhœa, and on other mucous membranes, as the conjunctiva, where inflammation assumes this form.

Cases of chronic vaginitis in young persons are observed in which the vagina is hard and small, its rugæ well seen, but yet evidently swollen, œdematous, and with either no secretion or covered over by an old, grayish-white accumulation of epithelial detritus.

URETHRITIS.

CAUSES.—Urethritis in the female is commonly classed as a venereal affection, and is unquestionably due in a majority of cases to extension of inflammation from the vulva or vagina. As in such instances the original disease may, as has been shown, be entirely non-venereal in its origin, and as there are in addition certain forms of urethral inflammation associated with and dependent upon bladder disease, pregnancy, malposition of the uterus, etc., it is certainly very unsafe to assume that any woman with a urethritis has necessarily acquired it by contagion, and as a result of exposure to the discharge resulting from a similar inflammation in a person of the opposite sex.

Dr. S. F. Carpenter¹ reports a case of cysto-urethritis of three years' standing in a woman who was at the same time affected with hemorrhoids and pin-worms. Measures directed against these latter troubles resulted in a complete cure of the urinary disorder within two months, it having previously resisted many other methods of treatment.

It may be admitted, however, that the existence of a urethritis in a female is presumptive evidence of impure connection, particularly in those cases in which it exists independently of any vulvar or vaginal affection. When these regions are involved, the question of original causation reverts to them, as their inflammations almost invariably precede the urethral trouble.

As to the frequency of the forms of gonorrhœa thus described, there have been considerable differences of opinion among distinguished authorities. Belhomme and Martin found urethritis in 112 out of 1607 patients; Weibert recognized it in 29 out of 175 cases; Cullerier found it in one-fifth of his cases; Langlebert and Swediaur coincide in their observations and believe it to be very rare; on the other hand, Bell, Ricord, Guérin, Rollet, Berkeley Hill, and Bumstead, speak of it as a not infrequent complication. Sigmund found urethritis and vaginitis combined in 476 cases; vaginitis without urethritis in 282 cases, and urethritis alone without any concomitant inflammation in only five cases. Jullien gives the following table furnished to him by M. Fournier, from the service of the latter at the Lourcine.

Vaginitis,	176
Urethritis,	150
Vulvitis,	22
Urethro-vaginitis,	81
Urethro-vulvitis,	5
Total,	434

¹ Kansas Medical Index, July, 1881.

He explains the discrepancies by assuming that the authors who frequently observe urethritis include the chronic with the acute cases; but as chronic urethritis is quite rare in women, this hardly seems to me satisfactory. The explanation will hold good, however, when applied to what I have said (p. 284) on the relative frequency of vaginitis, vulvitis, etc. I have there alluded only to the acute varieties of these complications, and have, as I have said, found them to occur with equal frequency, or with vulvitis rather in excess. Inflammation of the vagina is so much more apt to become chronic than inflammation of the vulva, which rarely does so, that a table like the above gives a very unfair idea of the relative prevalence of these varieties of gonorrhœa as met with in recent cases.

SYMPTOMS.—The shortness of the female urethra, its downward inclination from the neck of the bladder to the meatus, and the comparatively small amount of mucous membrane involved, prevent at the same time the formation of any large amount of discharge and the development of any extremely painful symptoms.

Ardor urinæ does exist in nearly all cases, and is sometimes quite marked, but has never in my experience been at all comparable in severity to the same symptom as observed in the male. The proximity of the inflamed area to the neck of the bladder renders some degree of involvement of that viscus quite common, but although urination may be much too frequent, the degree of tenesmus and the associated spasm and pain are less distressing than when cystitis occurs as a complication of male urethritis.

In many cases the spontaneous emptying of the urethra by gravitation, or its washing out by the stream of urine, is so complete, that to obtain evidence of the existence of a discharge it is necessary to insert a finger into the vaginal outlet and gently "strip" the urethra from behind forward, compressing it against the under surface of the pubic arch. This should be done some time after urination.

Occasionally the meatus will be found red, pouting, or everted, and it is sometimes surrounded by a ring of vegetations.

Jullien mentions the following diseases as possible sources of error in the diagnosis of urethritis in the female, giving with each its characteristic symptoms.

Vesical Neuralgia: Frequent and urgent calls to urinate; vesical tenesmus, each drop of urine provoking the most agonizing spasm; intense pain during catheterism; no discharge; urine limpid; usually associated with anal neuralgia; often occurs at a menstrual period.

Vesical Calculus: Relatively rare in women, and above all in young girls; antecedent history of gravel or gout; absence of discharge; vesical tenesmus; urine turbid or sanguinolent with heavy sediments; symptoms often intermittent; reflex pains in the thighs, lumbar regions, and genital apparatus; detection of calculus by vaginal examination.

Urethral Chancre: Easily seen if situated at the meatus; induration of the urethral wall recognized by palpation; discharge slight or absent.

Vascular Growths or Polypi of the Urethra: Less common with young unmarried girls than with married women; a pedunculated tumor easily seen when near the meatus; no purulent discharge; clear mucous hypersecretion; occasionally hemorrhage; if the size of the growth be considerable, great hyperæsthesia; intense pain in the vulva augmented by pressure or motion; a feeling of weight in same region; reflex lumbar and femoral neuralgias; ardor urinæ; painful coition; general health depreciated.

UTERINE GONORRHOEA.

The form of uterine inflammation set up by gonorrhœa is usually *endocervicitis*. In nearly every case in which the upper portion of the vagina is

implicated in the disease, the os uteri is bathed almost constantly during the height of the inflammation in an acrid, irritating pus. It is not to be wondered at that in many cases the irritation thus engendered, instead of limiting itself to the production of congestion, abrasions, superficial ulcerations, and other changes in the os, extends into the neck and sometimes into the body of the uterus, producing in each instance its characteristic symptoms.

In the former case, there will be seen upon examination with a speculum, a red, swollen, ulcerated os, from between the lips of which protrudes an albuminous, mucous or muco-purulent discharge, viscid and coherent so that it is detached with difficulty. It does not differ in any respect from the discharge often found in weak, debilitated females, broken down after child-birth or for other reasons, and known as one of the varieties of leucorrhœa. When this discharge, which is neutral or alkaline, comes in contact with the acid secretions from the inflamed region, it coagulates, becomes milky, and is often found as semi-solid lumps mixed with the more fluid vaginal flow. The same change occurs in it when injections or suppositories of various astringents are used in treatment, and this new phenomenon often gives rise to considerable alarm on the part of the patient unless she has been told of it in advance.

When the disease extends to the lining membrane or to the body of the uterus itself, when it advances through the Fallopian tube to the peritoneal cavity or to the ovaries, or when in other cases it extends from the submucous connective tissue of the vagina to that which lines the pelvis, it produces complications which are of the most extreme gravity.

A description of metritis, ovaritis, peritonitis, or pelvic-cellulitis, when those affections result from gonorrhœa, would not differ in any way from that of the same conditions occurring idiopathically or as sequelæ of other diseases, and may be found more appropriately in the text-books on gynecology.

TREATMENT OF GONORRHOEA IN WOMEN.

TREATMENT OF VULVITIS.—The speedy cure of a case of *vulvitis* depends upon attention to the following points:—

The patient should be placed at absolute rest with the pelvis elevated; this is more important in this than in any other variety of female gonorrhœa, gravitation, and the friction produced by movement, operating powerfully and prejudicially if the patient insists upon going around. Perfect cleanliness and dryness of the parts are essentials of success in treatment. The labia should be gently washed every two hours with a strong solution of bicarbonate of sodium, which will dissolve and remove all accumulated sebum and mucus, and will at the same time often prove to be, in itself, a very soothing application. In using this, the labia should be gently separated with the thumb and fingers of one hand, while with the other a stream of the alkaline solution is squeezed out of a sponge held a short distance above. After this operation is completed, a soft old linen rag should be held in contact with the vulva until all the fluid is absorbed, the parts should be dusted with a fine powder of starch and oxide of zinc, or of opium and lycopodium, a piece of patent lint should be carefully interposed between the labia, and absolute quiet should be preserved until it is time to repeat the dressing. In certain cases the inflammation runs so high—the swelling, pain, and discharge are so excessive—that these gentle measures do not suffice. It will then be necessary to purge, to employ prolonged, general hot-baths—not sitz-baths—to follow them with a lotion of opium and lead-water kept contin-

nally on the inflamed region, or to paint the entire vulva with a forty-grain solution of nitrate of silver. This last expedient may be adopted earlier, and rarely fails to produce a good effect. When the burning and throbbing are very great, and particularly if there is some constitutional disturbance, the abstraction of blood by leeches placed along the lines of the groins, and on the perineum, is clearly indicated. The diet during this period should be restricted, consisting chiefly of milk and farinaceous articles.

When it becomes apparent that a *vulvo-vaginal gland* is involved, timely local bleeding may arrest the inflammation, but if it fail to do so, suppuration may be hastened by warm fomentations, cloths wrung out of hot water and laid over the affected labium being preferable to poultices. Some difference of opinion exists as to the best locality for evacuating the abscess if it fails to empty itself through the duct, but I have never seen any ill effects from making the incision on the inner and lower aspect of the swelling, and believe that it is possible to obtain the best drainage in that manner. It is asserted that the contact of the urine and other discharges with the wound at that point is objectionable, but this has not been so in my cases, and I have never taken any precaution to make the cut "valvular," or otherwise to protect it. In chronic, frequently recurring abscesses of this region, instead of dissecting out the capsule of the gland, as has been recommended, or of putting in a seton, I have always found it sufficient to lay open the cavity by a free incision, and to pack the wound with lint greased with carbolized oil. In some eight or nine cases thus treated, granulation has taken place from the bottom of the wound, and no recurrence of the abscess has followed.¹

When superficial ulceration of the vulva results from vulvitis, and particularly when the ulcers are irritable and painful, iodoform often produces the happiest effect, reducing pain and at the same time stimulating the sores to healthy reparative action. In private practice, and with women who are delicate or sensitive about themselves, the odor of iodoform is often a serious objection to its employment. This odor cannot be altogether overcome, but the following formula has in my experience been the most satisfactory in that respect, the pungent, penetrating character of the smell being certainly agreeably modified.

R.—Iodoformi, ʒj.
 Ol. ylang-ylang,
 Ol. rosæ,
 Ol. anisi, āā ʒv.
 Unguent. aquæ ros. ʒss.—M.

TREATMENT OF VAGINITIS.—Vaginitis requires the same general management as vulvitis—rest in bed, elevated buttocks, restricted diet, and attention to cleanliness being all valuable adjuvants to treatment. The confinement to bed is hardly so imperatively necessary as when the vulva is the seat of the disease, and motion does not through friction, or in any other way, so greatly aggravate the symptoms. The patient should, therefore, be particularly cautioned against undue exercise, and also against indulgence in sexual intercourse. In markedly inflammatory cases this will not be necessary, as the pain induced by attempts at intromission will be a sufficient preventive. In cases of acute vaginitis, with profuse purulent discharge, tumefaction of the mucous membrane, etc., the routine treatment should be as follows:—

¹ Dr. Matthews Duncan treats cases of vulvo-vaginal abscess by dilating the duct of the gland with a large probe, and injecting the abscess cavity with a twenty-grain solution of nitrate of silver by means of a lachrymal syringe (*Medical Times and Gazette*, February 21, 1880). In the *Lancet*, for March 3, 1877, he reported a case of persistent inflammation cured in this manner.

The patient, being in bed with the buttocks resting upon a hair pillow or a folded sheet, the bowels having been opened with a saline laxative, should be instructed to wash out the vagina every two hours with an injection of a pint or two of soap and water—or, if that prove irritating, with an alkaline solution—to follow this with a pint of simple water, and to conclude with the use of a pint of some medicated solution, preferably at this stage one of acetate of lead. This at first sight seems like a tedious and rather formidable procedure, but it is really very easy of accomplishment, and requires but a few moments for its performance. Before using the injection, the patient may, if she choose, move to a lounge, or preferably to an old blanket spread upon the floor. She should employ a Davidson's or Mattson's "family" syringe, using the long nozzle. This should be greased with a little cosmoline, and gently inserted into the vagina to its entire extent, the patient lying on her back with the heels drawn up to the buttocks. The rubber tube, to the end of which the leaden sinker is attached, should then be dropped into a basin of water, in which a piece of white Castile soap has been briskly stirred, or into one containing two or three teaspoonfuls of bicarbonate of sodium in solution. A bed-pan, a piece of rubber cloth, a big sponge—or, better still, some old muslin or flannel rags—being placed beneath the nates, so as to catch or absorb the overflow, the injection should be given in the usual manner, by regularly compressing the India-rubber bulb; after which, by a simple transference of the sinker to a basin or other vessel of clear water, the soap can be washed out, and the vagina thus prepared for the astringent or sedative solution which it is thought best to use. This, having been previously prepared in a wide-mouthed bottle, or another basin, may be given in the same way, and the syringe may then be withdrawn. After a very moderate experience the patient will be able to go through with this process in five or ten minutes, and with perfect comfort.

The materials used as injections are various, but belong chiefly to the classes of astringents and antiseptics. In the therapeutic value of the latter in the treatment of vaginitis I have no faith—permanganate of potassium, carbolic acid, Labarraque's solution, and others, having seemed to me to be of no more value, except possibly in correcting offensive odors, than as much cold water. I have used them in hospital practice in a sufficient number of cases to be able to pronounce upon this point with some positiveness. In the great majority of cases it will be found best to use at first the acetate of lead, to follow this, as the pain subsides and the inflammation becomes less acute, with alum or the acetate or sulphate of zinc; and when, under this treatment, the pain has entirely disappeared and the discharge has become watery, to pack the vagina with tannin, or to use suppositories, according to circumstances. In prescribing vaginal injections for women, it is always well to order the material in powder, telling the patient how much to dissolve in a given quantity of water. For use in a pint of water, for instance, she should employ of

Acetate of lead,	one teaspoonful—three drachms.
Acetate of zinc,	two teaspoonfuls—three drachms.
Sulphate of zinc,	one teaspoonful—two drachms.
Alum,	one teaspoonful—two drachms.
Tannin,	four teaspoonfuls—two drachms.

These should be diluted when it is found that they occasion pain.

The hot vaginal douche recommended so strongly in various gynaecological conditions by Dr. Emmet, of New York, will sometimes be found of great service in the treatment of vaginitis. Its use should, however, be limited strictly to those cases in which the patient herself recognizes its benefit, and should never be persisted in if it gives pain or is followed by increased fulness with throbbing of the parts; or, as in cases reported by

Dr. A. Reeves Jackson,¹ by intense arterial congestion. The temperature of the water should range from 100° to 110°, or even 120° F. In certain cases, especially of chronic vaginitis, Duncan² also recommends the use of the hot douche, large quantities of water at blood-heat being thrown into the vagina with considerable force.

If the patient be in good circumstances, the subsiding stage of a vaginitis will be best treated with vaginal suppositories, which may be used thrice daily, the supine position being observed for at least an hour after the introduction of each one. As examples of useful formulæ, the following may be given:—

- R.—Ext. opii, gr. iij.
 Acidi tannici, ℥j.
 Ol. theobromæ, q. s.
 M. et ft. suppositoria no. xij.
- R.—Morphiæ sulphat. gr. iij.
 Liq. ferri subsulphat. f℥ij.
 Ol. theobromæ, q. s.
 M. et ft. suppositoria no. xij.
- R.—Pulv. aluminis,
 Cerat. plumbi subacet., āā ℥ij.
 Ol. theobromæ, q. s.
 M. et ft. suppositoria no. xij.

In ordering these, the patient should be informed that they will stain her linen if allowed to come in contact with it.

In some women with whom oily applications prove objectionable, or in those too poor to use suppositories, it will be well to pack the vagina with strips of patent lint, into the meshes of which tannin or powdered alum has been rubbed. This must be done through a speculum, the instrument being gradually withdrawn as the vagina is filled. A T-bandage or ordinary napkin is then applied, and the dressing allowed to remain for twenty-four hours, or even longer if it does not become offensive at the end of that time. This is a very efficacious method of treatment, but is not as cleanly as the use of suppositories, and involves both more exposure of the patient and more labor on the part of the surgeon.

Occasionally, when the vagina remains irritable, raw, bleeding easily, and resenting the most gentle introduction of a speculum, it will be well to apply to its surface very thoroughly a strong solution of nitrate of silver, 40 to 60 grains to the ounce of water. This is best done by inserting a cylindrical speculum, elevating its outer extremity, pouring into it two or three fluidrachms of the silver solution, and then gradually withdrawing it. As the vagina falls into the end of the tube, it will be thoroughly bathed in the liquid.

At night, in all cases of vaginitis, it will be found convenient to employ little pledgets of absorbent cotton into which some medicated powder has been rubbed. The patient should keep, on a chair or table beside the bed, two or three of these little rolls, and on waking during the night should insert one as far as the finger will carry it, first, of course, withdrawing the previous one. Lead, zinc, and tannin, may be used in this way, the former usually with the greatest advantage.

There are very few cases of vaginitis which will resist this general plan of treatment, and indeed I have never seen any, exclusive of those cases of long-continued vaginal catarrh in old prostitutes, which are practically incurable on account of the habits of the patients.

Tonics, careful diet, sea-bathing, and continual abstinence from coitus, will be necessary now and then to remove the last vestiges of the disease, which will rarely give any further trouble.

¹ St. Louis Clinical Record, June, 1879.

² Medical Times and Gazette, June 26, 1880.

TREATMENT OF URETHRITIS.—Urethritis in females, as a rule, runs its course very rapidly, and requires but little attention. Injections may be used by the surgeon, their strength being carefully adapted to the sensibility of the mucous membrane, and the almost certainty of their entering the bladder being remembered. The same principles of treatment hold good, and the same solutions are useful, as in urethritis in the male, lead, zinc, and silver being the substances preferred. Copaiba, cubebs, and sandal-wood oil may also be administered with advantage, acting as usual through the urine. No mention has been made of their employment in speaking of the treatment of other forms of female gonorrhœa, as in them the anti-blennorrhagics are worse than useless. Occasionally it may be necessary, in chronic cases, to wipe out the urethra with a probe wrapped in cotton and dipped in a solution of from 20 to 40 grains of nitrate of silver, and in some instances the solid stick has been employed.

TREATMENT OF UTERINE GONORRHOEA.—The affections of the *uterus* produced by gonorrhœa require no distinctive or peculiar therapeutic management. Nitrate of silver for abrasions, leeches for congestion, tampons or suppositories applied through a speculum and retained in contact with the os by elevation of the hips, iodoform, iodine, and all the well-known articles of the gynæcological armamentarium, are here as useful as in other uterine affections; and the same remark applies to the other pelvic and abdominal troubles which may complicate or follow a vaginitis.

GONORRHOEA IN ANOMALOUS SITUATIONS.

Gonorrhœa of the ear, mouth, nose, umbilicus, axillæ, and rectum has been described by various authors as constituting, in each instance, a distinct variety of the disease, arising from contagion. I may say at once that, having never met with a single instance of any of these complications, I have no belief in their existence; and a review of the literature of the subject but tends to confirm this skepticism. I will quote only a few of the best known authorities:—

Jullien¹ says: “We may pass by in silence the auricular, buccal, axillary, and umbilical varieties of gonorrhœa, which have not even been proved to be possible.”

Berkeley Hill² has never seen such cases.

Bumstead³ has never met with an instance of gonorrhœa of the rectum, and thinks that the existence of the other varieties “may well be doubted.”

Lebert,⁴ although expressing a belief in the existence of gonorrhœa of the rectum, does not say that he has ever seen such a case, and does not allude to any of the other supposed varieties.

In all these works we find quoted a single absurd case reported by A. M. Edwards,⁵ of a widow who was affected with a serious catarrhal and ulcerative condition of the Schneiderian membrane, and who was discovered to have six months previously used a handkerchief supposed to have been contaminated by her son who was at that time suffering from gonorrhœa! Jullien,⁶ in addition, mentions one or two mythical cases of nasal gonorrhœa—one reported by Andrew Duncan, in 1784, and one by Forçades, who attributed it to metastasis, and asserted that it was cured by reproducing the urethral discharge. Hecker, physician to the King of Prussia in 1787, describes

¹ Op. cit., p. 212

³ Op. cit., p. 211.

⁵ Lancet, April 4, 1857.

² Op. cit., p. 585.

⁴ Ziemssen, op. cit., vol. viii. p. 808.

⁶ Op. cit., p. 209.

nasal gonorrhœa, but does not seem to have seen any cases, and apparently founds his description on that of Duncan.

Vidal (de Cassis)¹ quotes from Baumès the case of a workman, who, after kissing the vulva of a woman affected with gonorrhœa, developed an engorged, tumefied, red, hot, painful condition of the left half of the lower lip, with whitish granulations and a moderate purulent discharge. It developed six or eight days after the exposure to infection, and had already lasted six weeks when it came under observation. It obstinately resisted emollient treatment, as applied by M. Baumès.

Although there was, apparently, in this case, a direct relation of cause and effect between the gonorrhœal and the labial diseases, yet it does not follow that they were of the same character. Already existing mucous patches, inflamed by contact with irritant pus, or a severe form of herpetic ulceration, would be accompanied by all the above-mentioned symptoms, and would offer a much more satisfactory explanation of the phenomena.

Of course inflammation, eczematous irritation, or even suppuration, with abscess or ulceration, may occur at any time from contact of irritating or unhealthy pus with a delicate mucous membrane, and this is especially apt to be the case if the individual is broken down in health, poorly nourished, or of intemperate habits. But that gonorrhœal pus rarely if ever excites such action, must be evident, when we remember the numerous opportunities for observation enjoyed by the authorities quoted, none of whom appear to have seen a single authentic instance of these forms of infection.

In regard then to all the varieties except that affecting the rectum, we may conclude that there is an entire lack of satisfactory evidence that, as definite or recognizable affections, they ever exist. As to gonorrhœa of the rectum, the evidence appears to be a little stronger, but still far from convincing:—

Allingham² reports three cases, which he says were examples of undoubted gonorrhœa of the rectum, occurring in prostitutes who all confessed the manner in which they had become affected. The mucous membrane as seen through a speculum was intensely inflamed, but the inflammation did not appear to affect the submucous areolar tissue. In the fourth edition of Mr. Allingham's work (Philadelphia, 1882), I have been unable to find any report of these cases, and am compelled to believe that the author has purposely omitted them, possibly feeling some doubt as to their authenticity.

Tardieu³ reports a case in which a copious greenish discharge occurred at the *anus* of a man after he had had unnatural relations with another who was affected with gonorrhœa, but I have been unable to find any description of the condition of the rectum.

Bumstead, Hill, and Lebert, as has been mentioned, have never seen a case of this kind.

Diday⁴ has never met with any case, and after having experimented more than thirty times by conveying gonorrhœal matter to the nostrils, lips, and anuses of various patients, and having in each instance failed to produce any result, says that among extra-genital gonorrhœas he can only hold as indubitably proven the existence of one form—gonorrhœal conjunctivitis.

Jullien⁵ describes an *anal* gonorrhœa, but says that experimental inoculation has proved that the disease cannot pass the limits of the muco-cutaneous orifice, where the cylindrical is replaced by pavement epithelium.

The symptoms which he details do not differ from those which I have many times seen produced by contact of gonorrhœal discharges with the anus, but have always attributed to a form of eczematous irritation. This occurs

¹ *Maladies Vénériennes*, p. 188. 2e édition, Paris, 1855.

² *Diseases of the Rectum*, p. 237, edition of 1871.

³ *Étude médico-légale sur les attentats aux mœurs*, p. 235, 6e éd. 1873.

⁴ *Op. cit.*, p. 129.

⁵ *Op. cit.*, p. 213.

chiefly in dirty and degraded prostitutes who are careless of personal cleanliness, and who permit the vaginal discharges to flow over the perineal and inter-gluteal regions. It is accompanied by the usual signs of dermatitis: heat, redness, itching, vesiculation or pustulation—sometimes by actual ulceration, which is most apt to occur in the folds of the anus and to follow them upward, assuming a linear form, and becoming true fissures. It is often associated with the formation of external hemorrhoids, and sometimes with the development of warts, but has never appeared to me to have any peculiar characters whatever, and has never, in the cases which I have seen, extended up into the rectum. Cleanliness and zinc ointment, or some desiccant powder, are usually speedily curative.

[THE MICROCOCCUS OF GONORRHŒA; THE GONOCOCCUS.]

Originally discovered by Neisser, in 1879, the so-called *gonococcus*, or *micrococcus gonorrhœæ*, is now believed by many writers to belong exclusively to gonorrhœa, and to furnish, therefore, a proof of the specific character of the disease. According to Cheyne, gonococci ordinarily occur in pairs or groups, and their opposing surfaces are flattened. They are found in the earliest stages of the disease, and become fewer as this becomes chronic. Bumm has succeeded in cultivating them on sterilized blood-serum, on which they form a thin, greyish-yellow coating, and by inoculating the organisms thus cultivated in the urethra of a healthy woman, has induced the development of a violent gonorrhœa. They are said to have been found in the synovial fluid in cases of gonorrhœal rheumatism. On the other hand, various observers have found micrococci, indistinguishable from the gonococcus, in normal human saliva, in ordinary pus, and in other fluids; and De Amicis has seen them in the discharge from a case of urethritis artificially induced by the use of ammoniacal injections.

In view of these conflicting opinions, it will still be prudent for the practical surgeon not to pin his faith on the invariably specific character of gonorrhœal discharges, but, as advised on page 223, to give his patient the benefit of the doubt in all cases in which the source of infection is uncertain.]

VENEREAL DISEASES: THE SIMPLE VENEREAL ULCER OR CHANCROID.

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SYNONYMS.

French : *Chancroïde*; German : *Schanker*.

It was supposed, upon the acceptance of Bassereau's law of the difference in nature between the local venereal ulcer and the initial lesion of syphilis, and upon the consequent formation (although not by him) of the two schools of dualists and unicists, that all further doubts as to the characters of these two diseases had been entirely set at rest; but such would seem to be far from true. Later experiments with pus taken from various sources, throw serious question upon what had heretofore been considered as one of the strongest diagnostic points of the simple venereal ulcer, that is the capacity for auto-inoculation; and the existence of a virus for this form of venereal ulcer is at the present day, if not openly denied, at least openly doubted. To quote the words of a late authority upon this subject, one who was the first in this country to teach the doctrine of dualism, and the difference in the virus of chancre and syphilis :—

“The chancre . . . does not depend upon a specific virus of its own, incapable of being generated *de novo*. . . . If the view here advocated be the correct one, it suggests an interesting analogy with the history of our belief as regards the nature of gonorrhœa, an affection which in the last century was regarded as due to the syphilitic virus. Ricord finally adduced convincing proof that it had nothing to do with syphilis. It was afterwards supposed to depend upon a virus of its own—the gonorrhœal virus. We now know that it may be caused by any simple irritant, but more especially by the pus from the urethral and other inflamed mucous membranes, whether originating or not in contagion. Such as the history of gonorrhœa has been, so we predict the history of the chancre will be.”¹

In view of such decided changes in opinion, I propose in this article to trace out the causes which have led to them, and, as far as is possible, to lay before my readers the views at present held by syphilographers upon this subject.

¹ Bumstead and Taylor, Pathology and Treatment of Venereal Diseases. Fourth Edition. Philadelphia, 1879.

HISTORY AND NOMENCLATURE.

Until the year 1852, all venereal ulcers were regarded as due to the same cause—as produced by the same poison or virus—and were all called by the same name, viz., Primary Syphilis. It is true that Hunter, Ricord, and other less well known writers on venereal diseases, recognized the fact that only a certain proportion of ulcers of the genitals were indurated, and followed by subsequent manifestations elsewhere upon the body; yet the fact remains that the broad distinction of a difference in nature was not recognized, and that all these ulcerations, soft as well as hard, were grouped together under the common head of Syphilis. In the year mentioned, Bassereau, a pupil of Ricord, published a work¹ in which he openly advocated a difference in nature between these two varieties of venereal ulceration, and by a system of confrontation—that is, by tracing the lesion of any given patient to the person who gave it—he was enabled to formulate the following propositions:—

“Here, then, in a few words, are the conclusions at which I have arrived from confronting, not only those affected with erythema, but those also, the subjects of chancres and of syphilis of various forms, with the persons who infected them:—

“If a person who has been affected with chancres, followed by constitutional symptoms, is confronted with the person who gave the infection, or with those to whom it has been communicated, it will be found that all such, without exception, have been affected with chancres followed by constitutional manifestations. The chancre is never purely local.

“On the other hand, if one who is affected with a chancre which has not been followed by any syphilitic symptom, be confronted by the person who has caused the infection, the former will be found to be the bearer of a chancre which is entirely local, and which does not infect the constitution. This admits of no exceptions.

“Thus, no chancre which is followed by constitutional symptoms gives rise to a purely local sore, nor does a local chancre, by contagion, communicate an ulcer which is capable of producing syphilis.”

Here we see clearly laid down the proposition that there are two distinct forms of ulcer, separate in their nature, and which never interchange, each producing its own kind; one of which is followed by constitutional symptoms, while the other never is so, but is always local.

There is no suggestion of a change in name as yet. That was reserved for another of Ricord's pupils, M. Clere,² who, in 1854,³ arrived at three conclusions:—

(1) That there are two well-marked varieties of syphilitic chancre: one indurated, which infects the entire organism; the second non-indurated, which does not infect the system, but is local and simple in nature.

(2) That each of these varieties of primary syphilitic ulcer transmits itself as a distinct pathological entity.

(3) That the simple chancre is the result of inoculation of the matter of an indurated chancre upon a person who either is suffering or has suffered from constitutional syphilis. Believing that it bore the same analogy to syphilis that varioloid did to smallpox, he gave it the name of “Chancroïde.”

Here, then, it is that we first find the name, chancroid, appear—a name by which the lesion is as well known in America as it is in France.

¹ *Traité des Affections de la Peau symptomatiques de la Syphilis*, pp. 197 *et seq.*

² I believe that this honor is claimed by M. Langlebert for M. Maratray, who, in a work, “*De la Syphilis primitive ou locale et de l'unicité du Virus Syphilitique*” (Paris, 1854), anticipated Clere by six months.

³ *Du Chancroïde Syphilitique.*

In 1857, three years after Clere's article was published, M. Fournier edited, for Ricord, a book¹ in which the differences between the simple venereal ulcer (chaneroid) and the initial lesion of syphilis (chancre) were acknowledged, and their diagnostic points of variance clearly laid down. Ricord, in other words, admitted that there were two kinds of venereal ulcer: the one local, non-constitutional; the other general, infecting the constitution, never local, but marking the beginning of syphilis. To quote his words: "Le chancre induré, Messieurs, est donc le prélude d'une diathèse, et cette diathèse, grosse de malheurs et d'orages, c'est la *vérole*, la *syphilis*, *lues venerea*." He acknowledged the two species, and adopted the name of chaneroid.

In 1858, MM. Diday and Rollet, of Lyons, published an article in the "Annuaire de la Syphilis et des Maladies de la Peau," entitled "Y-a-t-il une ou deux espèces du chancre?" in which the following statements were formulated:—

(1) "There are two varieties of ulcer which are transmissible by close contact, as well as by inoculation artificially.

(2) "One of these is always local; the other infects the entire system.

(3) "The local variety, which bears only a superficial resemblance to the constitutional kind, is called 'Chaneroid;' the constitutional ulcer is called 'Chancre.'

(4) "The two ulcers, when inoculated upon persons free from syphilis, produce each its own kind—chaneroid a chaneroid, chancre a chancre; but

(5) "If a syphilitic person, say a woman, have connection with a man who has a chancre, and an ulceration result, then this ulceration will assume mixed properties—it will have the softness and external characteristics of a chaneroid; but on the other hand, with this ulcer as with a true chancre, the woman can communicate to another man a *chancre* which will produce in him the pox."²

Confusion worse confounded. But to still further complicate matters, M. Diday, in 1863,³ proposed other changes in name. He wished to retain the word *chancre* for the initial lesion of syphilis, and to call the lesion which Clere had christened "chaneroid," "*chancrelle*," claiming that the name *chaneroid* would be thus left to designate those ulcers due to the inoculation of the syphilitic virus upon persons already syphilitic.

"Cette terminologie [*chancrelle*] a de plus l'avantage de laisser le nom de *chancre* disponible pour désigner une lésion d'ailleurs très rigoureusement comparable à la variole sous le rapport pathogénique: je veux dire la lésion que l'on voit naître de l'insertion du virus syphilitique sur un sujet qui a eu antérieurement la syphilis."⁴

Fortunately for medical literature, the name never was adopted, the words chaneroid and chancre being those in common use to designate the two varieties of venereal ulcer.

In 1858, Rollet, of Lyons, published a work, "De la pluralité des Maladies Vénériennes," and in 1861 another one, "Recherches cliniques et expérimentales sur la syphilis, le chancre simple, et la blennorrhagie, etc.," in which, while admitting the existence of the chaneroid as distinct from the initial lesion of syphilis, he claimed the existence of a third variety of ulcer, to

¹ Leçons sur le Chancre, professés par le Docteur Ricord.

² To make this fifth clause as clear as the words of the writer can make it, and to remove the suspicion of error in translation, I append it here in the original French: "Mais si un sujet, une femme par exemple, qui était antérieurement *vérolée*, a eu des rapports avec un homme porteur de chancre, l'ulcère que celle-ci pourra contracter offrira des caractères mixtes; il aura du chancre et la mollesse et tout l'aspect extérieur, mais d'autre part, avec cet ulcère là, comme avec un vrai *chancre*, cette femme pourra communiquer à un autre homme un *chancre* qui produira ensuite en lui la *vérole*."

³ Histoire naturelle de la Syphilis, Paris, 1863.

⁴ Op. cit., p. 16.

which he gave the name of "mixed chancre." This lesion he endowed with a dual nature, for he says:—

"Non seulement il y a mélange des matières contagieuses, lesquelles sont dès-lors susceptibles de transmettre les deux maladies dont elles proviennent; mais encore il peut y avoir inoculation des lésions syphilitiques par le pus du chanéroïde, et transformation de ces lésions en autant d'ulcères réinoculables."¹

He believed in an admixture of "virus" by inoculation, which was capable not only of transmitting a chaneroid but of producing syphilis. This, to a certain extent, is true, but only as regards the period at which the inoculation is made, whether early or late in the duration of the ulcer; for if made early, as the chaneroid has no true incubation, the result must and will be a chaneroid; if made late, the lesion having changed its character and being no longer chaneroidal but syphilitic, the result will be syphilis. Upon this point I shall take occasion to speak further when I come to consider the question of mixed chancre.

As far as the French and many American syphilographers are concerned, the matter stands as above stated, and the chaneroid, mixed chancre, and chancre—that is, the initial lesion of syphilis—are at the present day accepted facts in venereal medicine. Among English and German writers there would appear to be some dissent to the above views. The former have taken a long time to recognize the existence of the two kinds of ulcer, and even at the present day are inclined to doubt their existence. Mr. Hutchinson, whose name is as respected in this country as in his own, writes in the *Lancet* as follows:—

"The virus of syphilis may cause inflammation and result in ulceration and suppuration. Pus as produced is contagious, and this is my theory of all soft and non-infecting chancres. This pus does not necessarily contain specific germs of syphilis. It may or may not. If it does, the result is a *mixed* sore, which is very common. Dualists have not, and never had, the slightest basis for their creed. Chancres differ, it is true, but we have no duality of syphilis.² The soft sore is not syphilis, nor is it the offspring of a sister virus. The term dualism (if it means anything) I suppose must mean that there are two kinds of specific poison, each producing its specific results and incapable of transmutation or alliance. If my hypothesis is the true one, the soft sore is not the offspring of a specific virus, but is a side result from inflammation caused by it. If it were possible to exterminate all soft sores and destroy the secretions capable of producing them by contagion, we must expect in a few weeks again to find them reproduced."

Here then we find the belief that the *soft* sore, upon which I shall have something to say on a subsequent page, may or may not contain the germs of syphilis; a statement against which too strong a protest cannot be made, if by *soft* sore we are to understand the simple venereal ulcer or the *chaneroid* of the French writers. Mr. Hutchinson is after all only repeating the teaching of the dualists MM. Clere and Rollet.

The Germans, on the other hand, have with much wisdom never adopted the name chaneroid, but have always called the non-constitutional ulcer "*schanker*," and what other nations call chancre they call "*initial sclerose*," or, better yet, "*initial lésion*." They accept the existence of two kinds of venereal ulcer, which differ in their nature, and which, in their purity, have nothing in common. By rejecting the name "chaneroid," they have saved

¹ Op. cit., p. 36.

² No dualist, as far as I know, has ever contended that we have; on the contrary, dualists candidly admit that there is but one syphilis, and that the initial lesion is its beginning. They do, however, claim that there are two kinds of ulcer: the one syphilis; the other not.

themselves from much confusion and trouble, as they have also done by never adopting to any extent the terms "soft sore," "soft chancre," and the like, which the French and English-speaking writers so frequently use. It would have been much better if the adjective *soft* had never been used in speaking of venereal ulcers, because its general use is to designate the simple venereal ulcer (chaneroid), and when, as is sometimes the case, we find sores devoid of induration followed by the subsequent symptoms of syphilis, we lose sight of the fact that it is we, not the lesion, who have erred, and are prone to consider the division into simple and syphilitic ulcers a snare and a delusion. Induration of the initial lesion is *not a necessity in syphilis*; the initial lesion remains syphilis, even if it be soft; but an initial lesion never becomes a simple venereal ulcer, nor does this latter ever become syphilis.

The term "mixed chancre" is, in my opinion, another of those unfortunate names, only too common in the literature of the subject, which serve to confuse and bewilder the student of venereal diseases. In studying carefully the recorded cases of inoculation of this type of venereal ulcer, in the papers and larger works of Laroyenne, Rollet, Nodet, and many others, we are struck at once by two facts: (1) that the inoculations were made upon the bearers of the lesion, and not upon healthy persons; and (2) that the experiments were made at times when the chaneroid was at full blast, even supposing, which is by no means certain, the initial induration to have shown itself; and that hence the inoculation could convey nothing but a local ulceration, for a second infection of syphilis does not occur while the first one is active. Hence those auto-inoculations show nothing to prove the conveyal of syphilis by the pus of a chaneroid. Nor does confrontation in such cases show anything; the cases of Rollet, Nodet, Lindwurm, and others only show that the chaneroidal pus can be deposited upon the initial lesion of syphilis, that it will there excite inflammatory and destructive action, and that it is capable of auto-inoculation. To thoroughly set this matter at rest, the pus of such ulcers should be inoculated upon subjects free from syphilis, and care should be taken not to have blood or any syphilitic secretions mixed with the pus; when, if the theory is correct that there is an admixture of virus, such persons should, in the first place, develop at the point inoculated a simple venereal ulcer (chaneroid), and in the second place, at the proper time, the initial lesion of syphilis, followed by the subsequent development of the so-called secondary symptoms.

Curiously enough, this has been done, but with apparently another object in view than the one of settling the question of mixed chancre. The observation is reported by M. Melchior Robert, in his "*Nouveau Traité des Maladies Vénériennes*" (Paris, 1861). I give the case here in full, notwithstanding that it is defective in some of its details, because it is both instructive and interesting:—

"Madame J. was the subject of two cancerous ulcerations of the nose, one of the size of a franc piece, seated above the left nostril, the other, which was smaller, in a corresponding position on the right side. Both ulcers had begun eighteen months before as pruriginous nodules. Their surfaces were dry and of a grayish hue; their edges were very hard and salient; the auricular and submaxillary ganglia were not engorged.

"October 14. The larger ulcer was dressed with a layer of charpie which had been saturated with the pus of a chancre [that is, a simple venereal ulcer] from an inoculation recently made upon a patient affected with syphilis; this chancre originated in a simple ulceration.

"October 16. The inoculated ulcer suppurates abundantly and is reddened at its circumference. The other one remains dry.

"October 16 to 25. The peripheral inflammation has increased; the ulceration is extending; the floor of the ulcer is gray, the borders scalloped and undermined; secre-

tion is abundant, and the patient complains of severe heat and tingling in the part. No glandular engorgement.

"November 1. The ulcer, which has evidently become transformed into a chancre [chaneroid], is increasing in size.

"November 15. Obliteration of the edges, diminution of the inflammatory areola, and an inclination to granulation.

"November 25. Obliteration of the edges very pronounced; a narrow line of cicatricial tissue is commencing about the edges of the ulcer.

"November 30. Cicatrization progressing; a healthy granulation of the floor of the ulcer.

"December 15. The inoculated ulcer has partially cicatrized. Dressings with aromatic wine are now ordered. No sign of adenitis; no sign of infection.

"December 27. Complete cicatrization of the cancerous ulceration, with an ash-colored cicatrix. The small ulcer at the right side of the nose has also healed. No evidence of infection.

"The only dressings used were diachylon at the commencement and aromatic lotions at the end."

It is very much to be regretted that more details are not given as to the syphilitic patient from whom the pus of the "chancre of inoculation" was taken. Still, let us see what the facts as given are. We have a chaneroid—for Melchior Robert did not recognize the difference between the two varieties of venereal sores, but called them all chancres—we have a chaneroid, inoculated upon a syphilitic patient; pus from this chaneroid of inoculation is then taken and placed upon an ulcerating cancer of the face, in a person presumably free from syphilis, though, unfortunately, this is not specified. What is the result? A double infection? It certainly ought to have been if there is any truth in this admixture of virus, in this "mixed chancre." But in place of any twofold disease we only have one, and that local, a simple venereal ulcer, without any systemic infection occurring after it. And that is precisely what we should expect. With our present knowledge, I cannot subscribe to the belief of an admixture of virus, but can only regard such "mixed" ulcers as the results of twofold or double infections, which, following out their proper, natural course, cause the chaneroid to appear first, with its peculiarities of non-indurated base, purulent secretion, auto-inoculability, etc., this, after the period of incubation has elapsed, giving way to the initial lesion of syphilis, when the secretion gradually diminishes and becomes serous instead of purulent, the base assumes an induration which it did not have before, and the ulcer is no longer auto-inoculable, unless, perhaps, it is irritated into suppuration. I shall revert to this point when I come to consider the subject of virus.

CHARACTERISTICS OF THE SIMPLE VENEREAL ULCER.

When the difference in nature between the two varieties of venereal ulcer, the simple ulcer (chaneroid) and the initial lesion of syphilis (chancre), was formulated, attention was called to certain differences which obtained between the two, and which were considered as diagnostic; and it was taught that certain appearances were found in each one separately, which were not found in the other. These peculiarities of the simple venereal ulcer I shall now discuss in detail, calling attention to the changes of opinion which have taken place since 1852.

THE SIMPLE VENEREAL ULCER IS NOT INDURATED.—The first and the most striking feature about this variety of venereal sore is the supple base upon

which it is seated. The tissues upon which the ulcer is planted are entirely devoid of the induration which is generally found in the syphilitic variety; they are perfectly natural to the touch, except when this lesion is accompanied by very acute inflammation. They are then infiltrated with serum, and the base of the ulcer has a brawny, doughy feeling, which may simulate the induration of the initial lesion of syphilis. But a little care will prevent error, for the induration of the chancre has sharply defined limits, while the brawny base of the chaneroid has not, but gradually loses itself in the surrounding tissues. This œdematous condition is less likely to be confounded with the induration of syphilis than is another variety of infiltration not infrequently met with in chaneroids, and more particularly those of long standing. This infiltration closely resembles the parchment variety of induration, which is the only one likely to be confounded with it; but even here, in the large majority of cases, the educated fingers detect a want of clearness and sharpness of outline, which stamps it as something different from the "chancre à l'induration parcheminée."

Supposing, however, that the differential diagnosis should still be in doubt, auto-inoculation will settle the point, for this variety of ulcer is capable of reproduction upon the bearer of the lesion, the pus of the original sore giving rise to a similar sore by inoculation, while the secretions of syphilis are practically non-auto-inoculable.

In the very great majority of cases, however, the base of the chaneroid is absolutely soft; hence formerly, and even now to a certain extent, this ulcer was called the "soft chancre," to distinguish it from the initial lesion of syphilis, which was called the "hard chancre." But in time it was observed that some *soft* sores—very few, it is true, but nevertheless some—were followed by subsequent manifestations, and this revived the old dispute about the local nature of soft sores of the genitals. The fault was really one of nomenclature, not one of the nature of the lesions under observation; hence the tendency among syphilographers is to abandon the terms "soft venereal ulcer" and "chaneroid," while the ulcer which heretofore has been called "chancre" is now generally well known as the "initial lesion of syphilis."

THE SIMPLE VENEREAL ULCER HAS AN IRREGULAR FLOOR, AND IS ATTENDED WITH PROFUSE DISCHARGE.—The floor of this form of ulcer is one which differs from that of its congener. If we bear in mind that the simple venereal ulcer is eminently destructive in its nature, and that wherever it gains entrance beneath the outer covering, be it skin or mucous membrane, its action is corrosive, while syphilis during its early stage is not, we shall at once see the reason for the irregular, worm-eaten appearance of the bottom of the ulcer, for the dirty-yellow exudation which lines it, and for the copious amount of pus which it secretes. This is due to necrosis of the tissues, caused by what most syphilographers have, for want of more definite knowledge, called *the virus of the chaneroid*, but which is probably nothing more than intense inflammatory action. The walls of this simple venereal ulcer are worthy of notice: they are clean cut, judging from external appearances, giving the ulcer the look of being punched out of the tissues; but upon closer examination this clean-cut aspect is found to be only apparent, for the edges of the lesion are undermined. This is owing to the tendency which all chaneroids have to burrow, destroying tissue faster below the surface than above it; hence the real extent of these ulcers is usually larger than appears at a casual glance.

Here, then, are three important points in the physical aspect of the simple venereal ulcer, viz: the absence of induration of the base; the irregular yellow-looking floor, and the abundant secretion. But there is one other

characteristic of the chaneroid far more important than any yet mentioned, viz: its capacity for auto-inoculation.

THE SIMPLE VENEREAL ULCER IS AUTO-INOCULABLE.—Until very recently, this property was considered as peculiar to the simple venereal ulcer, no other kind of pus being deemed capable of inoculation upon the persons who bore the lesion from which the matter was taken. Later experiments have deprived the ulcer of this distinction, and yet I think the auto-inoculability of the chaneroid is still a very important point, and of great value in the diagnosis of doubtful cases, even though the pus of non-venereal skin-affectations, or of an artificially irritated initial lesion of syphilis, is occasionally susceptible of auto-inoculation. This property was correctly supposed to reside in the pus of the ulcer, and as no ordinary pus was considered to possess similar powers, the existence of a supposititious virus was invoked to account for the phenomenon. This convenient cloak for ignorance was termed the *specific virus of the chaneroid*, and was believed to be the cause of the existence of the simple venereal ulcer, and to account for its virulence. Let us examine the more recent experiments which have been instituted upon this subject, and see what bearing they have upon the existence of a special chaneroidal virus.

QUESTION OF THE VIRUS OF THE SIMPLE VENEREAL ULCER.—Ever since 1852, when Bassereau instituted his well-known confrontations, and when the diagnostic differences between the simple venereal ulcer and the initial lesion of syphilis were beginning to be recognized and better understood, innumerable inoculations and auto-inoculations have been made with chaneroidal pus, and no fact in venereal medicine is better attested than this characteristic of the chaneroid. But it was believed that only matter derived from the simple venereal ulcer was capable of auto-inoculation; and Ricord, in his “Lettres sur la Syphilis,” says:—

“I have inoculated upon the same patient, and that a hundred times, the pus of a chancre,¹ the pus of balano-posthitis, the muco-pus of urethral blennorrhagia, the pus furnished by phlegmonous inflammations of other parts, and while the pus of the chancre invariably produced a chancre, the other kinds of pus remained of negative effect.”

And the entire medical world has said “Amen” to this conclusion of Ricord. Recent experiments, however, have made us doubt the absolute correctness of this statement. In 1864 or 1865,² Dr. Pick, at the instigation of Zeissl, instituted in the hospital at Vienna some inoculations with pus taken from scabies, pemphigus, and acne pustules. The experiments were made upon syphilitic patients, and resulted in the production of pustules which were auto-inoculable for several generations, and did not in any way resemble indurated chancres. At the same time Pick made inoculations with the same pus upon the bearers of the lesion from which the matter was taken, and also upon other non-syphilitic patients, and they all proved negative.³

About the same time similar experiments were made by Drs. Kraus and

¹ For “chancre” read “chaneroid” wherever the word appears in the above extract; although this edition of Ricord’s letters was published in 1863, as revised and corrected, it is but too evidently a copy of previous editions, taken from and written for the “Union Médicale” in 1850 and 1851.

² Bumstead, in his fourth edition, says it was in 1865. But in consulting Zeissl, Auspitz, and Reder, I am unable to fix the time more positively than I have given it above.

³ Zeissl, Lehrbuch der Syphilis. Bd. i. S. 180 u. folg.

Reder at the Military Hospital at Vienna with pus of non-veneral eruptions. Here are the results; I give them from Reder's work:—¹

“Bærensprung believed that Bidentkap's² experiments lost much of their force from the fact that ulcerations of the skin could be produced upon syphilitic persons with ordinary pus, that is, with pus which was not obtained from chancres nor from syphilitic eruptions.

“Such inoculations, that is, with ordinary pus, were extensively made by Kraus and myself, and they showed that positive results were obtained only when the matter was taken from recent pustules. No inoculations succeeded when the matter was derived from long-standing pustules or from abscesses. The most marked results were those obtained from the matter of recent pustules in scabies pustulosa. As often as it was inoculated upon syphilitic patients, a pustule was developed at the point of inoculation, which was decidedly contagious during two or three generations, seldom more; this pustule did not give rise to any ulcer beneath it, but simply to a moist superficial excoriation. This was equally the case whether the inoculations were made upon syphilitic eruptions or upon apparently sound portions of skin. Each of these experiments was controlled by and compared with other inoculations made upon healthy persons with the self-same matter, but every one of these latter experiments was negative.”

Before going further, let us review the results furnished by these two sets of experiments. In both simple pus was inoculated upon syphilitic persons, and in both the results were positive, the inoculated matter producing pustules capable of still further auto-inoculation for two or three generations, and then ceasing. Certainly, as far as they go, the results tally with what we know about the auto-inoculability of the chaneroid, except that these experiments were made upon persons whose skin and mucous membranes were made irritable by their disease (syphilis), and who were debilitated, and whose blood was altered from the same cause. (Witness the examinations of syphilitic blood made by Ricord, Grasse, and others.)

Now, if the same property resides in simple pus that we know belongs to chaneroidal matter, the former ought to be inoculable upon healthy persons as much as are the latter. This is tried by all investigators, and in every instance the result is negative, showing that there is an element in the syphilitic skin favorable to inoculation which does not reside in the healthy skin. Is this due to syphilis? Pick thought so,³ but it is not clear that Kraus and Reder shared this belief, although it would have been perfectly natural that they should do so.

The next series of experiments was made by an American physician, Dr. Edward Wigglesworth, of Boston, Mass., while resident in Vienna, Austria, during the winter of 1867–8. These experiments have never, as far as I know, been published by himself, and although Dr. W. made me acquainted with the facts some years ago, they never, I believe, appeared in print until 1879, when they were mentioned in the last edition of Dr. Bumstead's treatise,⁴ from which I copy them. Dr. Wigglesworth wrote to Dr. Bumstead as follows:—

“I would state that I was free from all disease, whether hereditary or acquired, that I had never had a sore of any kind or any constitutional lesion of the skin or mucous membranes, and that I was merely a little run down from overwork in the hospital. I took from an acne pustule upon myself, pus, which I inoculated upon myself in three places, on the anterior radial aspect of my left forearm at the junction of the middle

¹ Pathologie und Therapie der venerischen Krankheiten, S. 25 u. folg. Zweite Auflage. Wien, 1868.

² These were made with the secretion from the initial lesion and from mucous patches, about which I shall have something to say on a subsequent page.

³ Ziessl, op. cit., Bd. 2, S. 56.

⁴ Op. cit., Introduction, p. 29.

and upper thirds, first pricking open the apertures of hair follicles, and then rubbing the pus into them. The result in the course of three or four days was three well-marked pustules. From each of these I inoculated one new spot upon the same arm, nearer the wrist. The result was three new well-marked pustules. From each of the three second series I again inoculated fresh spots still nearer the wrist, and again the result was positive. The second series was hardly as well marked as the first, and the third series was slightly inferior in vigor to the second; still all were well marked, the nine sores being at the same time upon my arm. On removal of the crusts, perceptible ulceration of the skin was found to exist. Zeissl, with whom I was studying at the time (1867-8), happened to be lecturing upon dualism, and requested me to show my arm to the class to prove the production of ulceration from properly inoculated simple pus. There were no buboes in my case, nor did the ulcerations require other treatment than exclusion from the air by means of a simple dressing and cleanliness. The scars remain to the present day."

The next experiments which I find recorded¹ are those made by M. Vidal, physician to the St. Louis Hospital, of Paris, which are published in the "*Annales de Dermatologie et de Syphiligraphie*" for 1872 and 1873, fourth year, page 350. He commences his article with the statement that in 1846, during his service as *interne* in the hospital of Tours, he had several times seen his "chef de service," Dr. Frederick Leclerc, inoculate the (pus) matter of ecthymatous pustules which were developed in the course of typhoid fever, upon the patients who had furnished the pustules. "These pustules," he says, "were frequently followed by the development of new pustules of ecthyma, identical with those from which the matter had been obtained." In 1852 and 1853, under the auspices of M. Vigla, and during an epidemic of typhoid fever, he undertook some fresh experiments. Two inoculations were made upon healthy men, who had never had typhoid fever, with pus taken from pustules of ecthyma in a typhoid fever patient. Both the inoculations were negative. The rest of the experiments were made upon the bearers of the ecthyma from whom the pus was obtained, and he asserts that in one-third of the cases he succeeded in producing pustules of inoculation. He does not give the number of the experiments which he made, nor the histories of the cases, except those of four patients. I give them here in some detail:—

CASE I.—R., aged 20, entered January 18, 1853, with an ataxo-adyamic typhoid fever of 15 days' duration. On January 26, an abundant eruption of ecthymatous pustules appeared upon the thighs, together with furuncles, an abscess on the chest, and the formation of a slough over the sacrum.

On February 3, pus was taken from one of the ecthymatous pustules of the thigh, and three inoculations were made upon the patient's left forearm. That same evening a slight redness appeared around two of the inoculated points. On February 4, the redness had extended, the skin was a little swollen, and a hard kernel could be felt. On the 5th, this had increased in size, and had commenced to point. On the 7th, four days after the inoculation, two perfectly characteristic pustules were seen, which dried up in 4 or 5 days. On the 8th, a fresh inoculation was made, and was successful. In this experiment Dr. E. Vidal introduced some dust and some of the patient's expectoration beneath the skin, in order to test the question whether it was simply irritation, or the pus-corpuscles themselves, which gave the successful issue to the experiment. These attempts were entirely unsuccessful.

CASE II.—In this case, on March 1, the 19th day of the disease, a cluster of ecthymatous pustules appeared upon the thigh. At the morning visit, an inoculation was made upon each arm. In the evening there was a slight redness at the inoculated points. On the 5th, the fourth day after the experiment, two very characteristic pus-

¹ Although these experiments were professedly made in 1853, they were not published until 1873. Hence they are placed here, although they antedate Pick's experiments by eleven years.

tules were visible. On the same day, at 10 A. M., some pus was taken from one of these pustules of inoculation and inserted beneath the epidermis of the forearm. At 7.30 P. M. it had already formed a red papule which was slightly prominent.

"The patient's death, upon the next day," says Vidal, "prevented me from carrying out this new experiment, which I had already seen succeed several times; pus taken from the pustules of inoculation causing the generation of new pustules of identical character."

CASE III.—Ch., aged 19, entered February 1, 1853, being ill with typhoid fever of 15 days' duration. Blisters had been applied to the chest and the calves of the legs, and numerous furuncles and ecthymatous pustules were developed in the neighborhood. On the 7th of February, matter was taken from one of the ecthymatous pustules of the chest, and three punctures were made on the left arm at 10 A. M. At 7 P. M. there was redness, itching, and slight puffiness at the inoculated points. On the 8th, a slight prominence, with redness, was visible. On the 10th, the prominence was very marked, surmounted by a pustule which on the morrow, the fourth day, was very characteristic. The same day I took pus from the pustules by inoculation, and made a fresh inoculation upon the same arm. In the evening there was a slight redness and swelling. On the third day, a pustule similar to the one which furnished the matter had made its appearance. The first pustule had begun to desiccate, and on the 16th of February, nine days after its inoculation, it had completely disappeared. On the 16th, the new pustule inoculated on the 11th was in full suppuration. On the 20th inst. it had dried. The crusts in falling off revealed a cicatrix.

On March 2, at 10 A. M., I tried a new experiment upon the same patient: I took the matter from a large sanguineo-purulent pustule, resembling a pustule of ecthyma cachecticum, which had developed round a blister on the left calf. This I inoculated upon the left arm. At 8 o'clock that evening there was an elevation, attended with itching. On the 3d and 4th, the redness and swelling had become more pronounced. On the 5th, the apex contained a dirty serum. On the 6th, the fourth day after the inoculation, a very marked pustule, seated upon a deep red, indurated base, was seen. On the 7th, this pustule, the size of a pea, contained a greenish pus; the base was less indurated. On the 8th, it broke during the night and dried up. On the 9th, it was covered with a greenish crust; the indurated base was getting softer. On April 24, when the patient left the hospital, reddish cicatrices showed the points of inoculation.

CASE IV.—B., aged 29, entered the hospital October 3, 1861. The patient, who was of a lymphatic temperament, and subject during childhood to eruptions and frequent attacks of ophthalmia, had for the last three months suffered with an impetigo of the face and of the anterior portion of the chest.

This affection, which presented all the characteristics of a simple impetigo, commenced to heal, when, upon the external aspect of the right forearm, four pustules of simple ecthyma made their appearance. On the 19th of October, without waiting for complete suppuration, I charged the point of a pin with serum from one of these vesicopustules, and made three inoculations upon the left arm. On the same evening, these three punctures were red, slightly swollen, and the seat of a smarting which attracted the patient's attention. On the 22d, the fourth day, three pustules had made their appearance. They consisted of a central phlyctenule, filled with a lemon-colored serum, and were seated upon a red, indurated base, surrounded by an areola. On the 23d, the pustules had changed into bullæ, which were not filled with pus. The contents were turbid. The mother pustule of the right arm, which had served for the inoculation, was covered with a crust, from beneath which serum exuded, which hardened upon exposure to the air.

On the same day (23d), an inoculation was made with matter from the young pustules, and a fresh inoculation with matter from the old ones. Besides these, three inoculations were made with ecthymatous matter which had been exposed to the vapor of the essential oil of turpentine. On the next day (24th), the following results were noted: (1) The inoculations made with the matter from the original pustules in process of reparation had succeeded perfectly; the vesicles were prominent and their periphery red. (2) Those made with matter from the pustules already inoculated, or of the second

generation, were less successful; the epidermis was elevated, but the red peripheral circle was slight. (3) Those made with matter which had been subjected to the vapor of the essential oil of turpentine were the poorest of all. The centre of the puncture was hardly raised, slightly papular; the reddish areola was almost entirely wanting, and the centre of this rudimentary vesicle was of a yellowish hue, a characteristic which the other inoculations did not present.

On the 25th (the seventh day), the pustules of the first inoculation had begun to dry; they were covered with a yellowish crust. The peripheral redness had disappeared, leaving a slight puffiness. On the 27th, inoculations were made with the matter from the second generation of pustules. These healed up rapidly, the punctures being marked on the following day by a slight prominence; the pustulation had aborted. A progressive decline in these inoculations was noticed; the last made were the first to heal. The capacity for inoculation diminished with each new generation, and the third one gave an insignificant result. Nevertheless, the subject did not lose the aptitude for inoculation, which was proved by new and characteristic pustules being obtained by inoculation of matter from the spontaneous pustules.

I have given these cases fully, because of the care and thoroughness with which they are reported, and because they are of great importance in their bearing upon this question of auto-inoculability. It must be borne in mind that, at the present day, it is believed that the simple venereal ulcer is the only lesion which possesses auto-inoculable pus, and this peculiarity has been claimed as of great importance in a diagnostic point of view. If, now, we can show any well-attested cases where simple pus—by that I mean pus not derived from a chaneroid nor from syphilis—has been capable of auto-inoculation, the importance of auto-inoculation as regards the chaneroid is very much diminished. Let us, then, review the cases just reported, and see what deductions we are justified in drawing from them.

In the German series, the cases of Pick, Kraus, and Reder, simple pus is inoculable only upon syphilitic patients, and upon no others; hence it is inoculable only upon a limited number of subjects, but upon them it is auto-inoculable for three generations.

In the American case, Dr. Wigglesworth's, no attempt is made to inoculate healthy persons, but simple pus is auto-inoculable for three generations upon the bearer of the lesion, who, previously to and at the time of the experiment, is free from syphilis or any venereal taint, but who is debilitated.

In the French series, Dr. Vidal's cases, simple pus is auto-inoculable upon the bearers of the lesion, who are presumably free from syphilis, but who are suffering from typhoid fever in three instances, and in the fourth from a sickly constitution. In all these cases one feature is especially noteworthy: the subjects of the experiments are below par in point of health. The part syphilis plays in this auto-inoculability is only a secondary one, because many other cases in which syphilis is absent show the same capacity.

What then is it which makes simple pus sometimes auto-inoculable? The pus? Not altogether, else why should it happen that healthy persons are impervious to its action? I grant that sufficient experiments have not yet been instituted upon this point to enable us to say positively that this is always the case, but, as far as our knowledge goes, the contrary remains to be proved. In one particular, then, chaneroidal pus still retains its prominence, in that it requires no special soil for its propagation. But even here we must pause before committing ourselves to this statement. Is the chaneroidal pus always capable of inoculation and auto-inoculation? Under certain circumstances, rare it is true, it would seem not to be so, as a glance at the annexed tables will show.

INOCULABILITY OF THE SIMPLE VENEREAL ULCER.

Table I.

(Ricord, Leçons sur le Chancre, p. 389.)

	No. of inoculations.	Positive.	Negative.
At period of progress	12	12	0
“ “ stasis	44	44	0
“ “ transition	9	9	0
“ “ repair, well established	12	9	3
“ “ “ already advanced	3	3	0
“ “ “ very far advanced	7	2	5
Gangrenous chancreoid	1	0	1
Chancreoid after deep cauterization	1	0	1

Table II.

(Labarthe, Le Chancre simple, p. 88.)

At period of progress	11	11	0
“ “ stasis	9	9	0
“ “ transition	4	4	0
“ “ reparation	16	16	0
“ “ advanced cicatrization	5	2	3

Table III.

(Millet, Étude statistique sur la Maladie syphilitique, le Chancre simple, et la Blennorrhagie, p. 59.)

At period of progress, stasis, etc.	75	75	0
“ “ repair	8	0	8

Table IV.

(Ricord, op. cit., p. 394.)

At period of progress and stasis	5	5	0
“ “ transition	2	2	0
“ “ repair	6	6	0

Résumé.

Number of inoculations made	230
With positive results	209
“ negative results	21

All positive, during every stage except that of repair or of advanced cicatrization, where strength has been lost, where gangrene has destroyed the potency of the matter, or where it has been chemically altered by cauterization.

These inoculations, be it said, were made upon the bearers of the lesions and hence were auto-inoculations, but they show one point clearly, viz., that as they lose their inflammatory character they also lose their capacity for inoculation, and here is I believe the true explanation of the “chancreoid virus”—it is *inflammation*. Irritate a non-venercal pustule; excite it to inflammatory action; and I believe its pus will be capable of inoculation, in the same way that Mr. Lee, of London, rendered the secretion of the initial lesion of syphilis (usually not auto-inoculable) inoculable upon the bearer of the lesion. Until, however, that is done, it would be mere theory to say that it is possible, nor should we be justified in deducing any conclusions therefrom, but we can say this much:—

I. Auto-inoculation is not peculiar to, nor pathognomonic of, the pus of the simple venereal ulcer (chancreoid).

II. Simple pus is, under certain circumstances, capable of auto-inoculation.

III. This auto-inoculability is partially due to irritative inflammation affecting the pus, and partially to irritability of the tissues.

If now the above conclusions are accepted, what becomes of the “specific virus?” Would it not be better to drop it out of our vocabulary altogether, unless indeed we are ready to admit that simple pus is endowed with a specific virus which renders it auto-inoculable?

THE SIMPLE VENEREAL ULCER IS ORDINARILY MULTIPLE.—Another feature of the simple venereal ulcer is its multiplicity, due to two causes, the first and most important one being auto-inoculation, the second and least important being immediate contagion. When the contagious nature of this form of ulcer is remembered, it will not be deemed surprising that multiplicity is the rule rather than the exception, and this feature, when compared with the singleness of the initial lesion, is one of consequence.

The appended tables will show not only the tendency toward multiplicity which marks the simple venereal ulcer, but also the difference which exists in this respect between it and the initial lesion of syphilis. These tables are so suggestive that a few lines devoted to their teaching will not be wasted.

MULTIPLICITY OF THE SIMPLE VENEREAL ULCER AS COMPARED WITH THE INITIAL LESION OF SYPHILIS.

Table V.

(Ricord, op. cit., p. 34.)

Persons affected with simple chancres	.	.	.	.	.	.	.	.	254
" " " one chancre	.	.	.	.	.	.	.	.	48
" " " several chancres	.	.	.	.	.	.	.	.	206
In the following ratio:—									
Patients with two	.	.	.	.	.	.	.	.	32
" " three to six	.	.	.	.	.	.	.	.	116
" " six to ten	.	.	.	.	.	.	.	.	41
" " ten to fifteen	.	.	.	.	.	.	.	.	8
" " fifteen to twenty	.	.	.	.	.	.	.	.	4
" " twenty or more ¹	.	.	.	.	.	.	.	.	5
									206

Table VI.

(Fournier, Nouveau Dictionnaire de Médecine et de Chirurgie pratiques, 1867.
Art. Chancre, p. 86.)

Patients affected with simple chancres	.	.	.	.	.	.	.	.	329 ²
" " " one chancre	.	.	.	.	.	.	.	.	63
" " " several chancres	.	.	.	.	.	.	.	.	266
In the following ratio:—									
Patients with two	.	.	.	.	.	.	.	.	50
" " three to six	.	.	.	.	.	.	.	.	152
" " six to ten	.	.	.	.	.	.	.	.	45
" " ten to fifteen	.	.	.	.	.	.	.	.	8
" " fifteen to twenty	.	.	.	.	.	.	.	.	5
" " twenty to twenty-five	.	.	.	.	.	.	.	.	6
									266

Table VII.

(Debaugé, Traitement des Chancres simples par la Cautérisation au Chlorure de zinc.
Paris, 1858.)

Patients affected with simple chancres	.	.	.	.	.	.	.	.	118
" " " one chancre	.	.	.	.	.	.	.	.	50
" " " several chancres	.	.	.	.	.	.	.	.	68
In the following ratio:—									
Patients with two	.	.	.	.	.	.	.	.	22
" " four	.	.	.	.	.	.	.	.	11
" " six	.	.	.	.	.	.	.	.	11
" " six to ten	.	.	.	.	.	.	.	.	17
" " eleven to fifteen	.	.	.	.	.	.	.	.	6
" " twenty	.	.	.	.	.	.	.	.	1
									68

¹ M. Labarthe, in his thesis, "Le Chancre simple," speaks of having seen in 1868, in M. Fournier's wards in Lourcine, a woman who was the bearer of the prodigious number of seventy-five chancroids.

² In the article from which this is copied the figure is 327. As this is evidently erroneous, I have taken the liberty of changing it.

Table VIII.

(Sturgis, Records of Third Venereal Division, Charity Hospital, Blackwell's Island, New York, 1879-80.)

Patients affected with simple chancres	249
“ “ “ one chancre	104
“ “ “ several chancres	145
In the following ratio:—	
Patients with two	71
“ “ three	38
“ “ four	20
“ “ five	6
“ “ six or more ¹	10
	<hr/> 145

Table IX.

(Ricord, op. cit., p. 121.)

Patients affected with indurated chancres	456
“ “ “ one chancre	341
“ “ “ several chancres	115
In the following ratio:—	
Patients with two	86
“ “ three	20
“ “ four	5
“ “ five	2
“ “ six	1
“ “ nineteen	1
	<hr/> 115

Table X.

(Sturgis, Records of Third Venereal Division, Charity Hospital, 1879-80.)

Patients affected with indurated chancres	46
“ “ “ one chancre	45
“ “ “ several chancres	1
In the following ratio:—	
Patients with one	45
“ “ two	1
	<hr/> 46

Résumé.

Number of patients having chancroids	950
“ “ “ a single lesion	265
“ “ “ multiple lesions	685
“ “ “ indurated chancres	502
“ “ “ a single lesion	386
“ “ “ multiple lesions	116
Percentages of multiple chancreoid to total number	72.1
“ “ single “ “ “	27.9
“ “ multiple initial lesions to total number	23.1
“ “ single “ “ “	76.9

The small number of initial lesions in my tables is, I believe, due to the fact that in this city few patients enter hospital until the subsequent lesions of syphilis have declared themselves, and prefer to seek relief at the dispensaries for the initial lesion. In support of this statement, I would refer the reader to Tables XXXIV. and XXXV., p. 334.

The collated cases of the simple venereal ulcer amount to 950, of which number 685 were multiple, and 265 were single, or, to express it in percentages, the simple venereal ulcer is multiple in a little more than 72 per cent. of the total number of cases. Even this is probably under the number,

¹ Under this heading one patient had twenty-five chancroidal ulcers.

because in the table of my own cases many patients who are recorded under the heading of "affected with one," evidently had been, from the histories, the bearers of multiple lesions at the commencement of their cases, coalescence having converted their multiple sores into single large ulcers, when, as they presented only *single* lesions on their entrance into the hospital, they were so recorded.

With the initial lesion of syphilis this is different. Here the tables show the proportion of multiple ulcers to the whole number of cases to be only a little more than twenty-three per cent., or, if it be expressed in numbers, the initial lesion is multiple 116 times, and single 386 times, in 502 cases.

Hence, although not invariably, it may be generally assumed that multiplicity of lesions is the characteristic of the simple venereal ulcer as contrasted with the initial lesion of syphilis, and especially is this the case when the multiplicity occurs subsequent to and not at the time of coitus.

THE SIMPLE VENEREAL ULCER HAS NO PERIOD OF INCUBATION.—In the simple venereal ulcer there is another peculiarity which serves to distinguish it from the initial lesion of syphilis. When the pus comes in contact with mucous membranes or cuticle denuded of their epithelium, its action is produced at once—often within twenty-four hours after the matter has been deposited upon the tissues. Only exceptionally is its action delayed beyond the first seven or eight days after coitus, and then only if the matter is concealed in a follicle, or in a fold of the skin, which, from offering greater resistance to the action of the pus, delays the appearance of the ulceration. Hence we are accustomed to speak of this ulcer as being devoid of any period of incubation. Its action is immediate, subject only to the delay offered by the mechanical resistance of the tissues.

If now we examine the following tables we will see that in 381 cases, in which we have accurate information as to the time of its appearance, the simple venereal ulcer appeared within the first eight days in 310, and only in 71 cases subsequent to that time, and these instances of prolonged incubation are probably explicable upon the ground that the patients themselves were at fault as to dates¹—inasmuch as in several cases the ulcer had evidently been of long duration at the time when the patient stated he had first seen it—or else that the pus had been deposited upon some tissue which resisted its action for a length of time. At any rate, it is a significant fact that 310 of the 381 cases occurred within the first eight days after coitus.

TIME OF APPEARANCE OF SIMPLE VENEREAL ULCER.

Table XI.

(Millet, op. cit., p. 54.)

The simple chancre appeared from abrasion during coitus in	.	.	.	10 cases.
It was seen from one to three days after coitus in	.	.	.	52 "
From four to six days after coitus in	.	.	.	48 "
In eight days	"	"	.	53 "
" fifteen days	"	"	.	3 "
" twenty days	"	"	.	5 "
" forty-five days	"	"	.	1 case.
" sixty days	"	"	.	1 "
Dates are wanting in	.	.	.	28 cases.
Total	.	.	.	201 "

¹ In 48 out of 429 cases the data are so defective as to be of no value. See Tables XI. and XIII.

Table XII.

(Fournier, op. cit., p. 81.)

The chancroid was seen on the first day after the infecting coitus in	6 cases.
On the second day in	2 "
" third "	9 "
From the third to the fourth day in	4 "
On the fourth day in	3 "
" fifth "	1 case.
" sixth "	3 cases.
From the seventh to the eighth day in	13 "
On the ninth day in	1 case.
" tenth "	2 cases.
" eleventh "	1 case.
" thirteenth "	2 cases.
From the thirteenth to the fifteenth day in	3 "
" seventeenth to the twentieth day in	2 "
Total	52 "

Table XIII.

(Sturgis, Records Third Venereal Division, Charity Hospital, Blackwell's Island, N. Y., 1879-80.)

Chancroid seen 1st day after coitus in	5 cases.
" " 2d " " "	4 "
" " 3d " " "	2 "
" " 4th " " "	5 "
" " 5th " " "	6 "
" " 6th " " "	4 "
" " 7th " " "	12 "
" " 8th " " "	9 "
" " 9th " " "	5 "
" " 10th " " "	10 "
" " 11th " " "	1 case.
" " 12th " " "	2 cases.
" " 14th " " "	8 "
" " 18th " " "	2 "
No positive data could be obtained in	20 "
Total	95 "

Table XIV.

(Debauge, op. cit., p. 21.)

The chancroid seen in less than 24 hours in	6 cases.
" " " " two days in	5 "
" " " " three "	10 "
" " " " four "	5 "
" " " " five "	5 "
" " " " six "	3 "
" " " " seven "	1 case.
" " " " eight "	24 cases.
" " " " ten "	2 "
" " " " twelve "	11 "
" " " " fifteen "	7 "
" " " " seventeen "	1 case.
" " " " three weeks in	1 "
Total	81 cases.

Résumé.

Total number recorded	429 cases.
Of these, positive dates are given in	381 "
Data are uncertain in	48 "
Of these 381 positive cases, the chancroid was seen within 8 days after coitus in	310 "
After that time in	71 "
Of the 310 cases seen within 8 days after coitus, the chancroid appeared within 3 days after infection in	111 "
Or, expressed in percentages, the chancroid appeared within 8 days after coitus in 81.3 per cent. of the cases in which the data are positive.	

VARIETIES OF THE SIMPLE VENEREAL ULCER.

According to the appearances which the chaneroid presents during the different stages of its progress, it has received a variety of names, to wit: the follicular, the herpetiform, the ecthymatous, the *ulcus elevatum*, and the exulcerous. This multiplicity of names is to be regretted, as liable to produce confusion, and to obscure the fact that the lesions to which they are applied are accidents in the course of the disease, rather than well-defined varieties of the ulcer.

Thus, when the matter of a chaneroid is deposited within a *follicle*, its first appearance is as a small nodule surmounted by a slight depression, with a grayish floor. This nodule is due to the distended follicle, and the depressed apex corresponds to the mouth of the duct of the follicle. It should be borne in mind that the small ulcer does not represent the real extent of the chaneroid, inasmuch as the destructive action has been advancing more rapidly in the interior of the follicle than appears externally, and that hence these follicular chaneroids should be laid open prior to cauterization, so as to allow of a thorough destruction of the ulcer.

The *herpetiform chaneroid* is simply one which is seen very early in its course, before the contents of the vesicle have become purulent, and is apt to lead to error by causing the chaneroid to be mistaken for a simple attack of herpes. Its subsequent course differs in no respect from that of an ordinary chaneroid.

The *ecthymatous chaneroid* is simply one which has been covered with a crust by the drying of the secretion from exposure to the air. Removal of the crust reveals all the usual characteristics of the ulcer.

The *ulcus elevatum* has been a source of much confusion, owing to its simulating the initial lesion of syphilis. It is due to causes which have already been discussed in a previous portion of this article. This ulcer is usually attended with marked inflammation and exudation about the base, which cause an elevation of the tissue upon the apex of which the ulceration is seated; hence the name. As the inflammation subsides the elevation becomes flattened, and the ulcer in its subsequent course exhibits all the characteristics of the chaneroid.

The *exulcerous chaneroid* is a superficial chaneroid, in which from the feebleness of the inflammation the destructive action is very slight, the edges are hardly undermined, and the secretion is scanty instead of being abundant. Indeed, to all intents and purposes this ulceration is a chaneroid which is incapable of extension, and which resembles in many respects an acute erosion of balanitis. It is hardly deserving of the separate classification accorded it by M. Clerc.

LOCALITY OF THE SIMPLE VENEREAL ULCER.

Until within a few years it was believed that certain regions of the body were exempt from being the seat of the simple venereal ulcer. Indeed, Ricord, as lately as in 1860, taught the following doctrine: "Up to the present there is no well-authenticated case of a soft chancre [that is, a chaneroid] developed upon the face, or, to put it in more general terms, of a cephalic soft chancre."¹ Later experience, however, proves that cephalic chaneroids do occur in sufficient number to demonstrate their existence, and to permit us to take exception to Ricord's formulated teaching given above.

¹ Leçons sur le Chancre, p. 18.



Chancroids.

But before taking up this question of cephalic chancroid, let us see upon what portions of the body the simple chancre is most likely to occur. Upon turning to the tables bearing upon this point, we observe that out of a total number of 1271 cases in the male, 1194 occur upon the genitals, and of these, 826 are recorded as occurring upon the glans penis, upon the prepuce, upon the fossa glandis, and upon the sheath of the penis; 24 at the meatus urinarius; 9 within the urethra; 9 upon the scrotum; 3 about the anus; 3 on the finger; 5 upon the leg; 1 on the anterior thoracic region; and 1 on the nates. In the female we have the following record: the external genitals were the seat of the simple venereal ulcer in 185 cases; the meatus urinarius and its vicinity, and the urethra, in 26 cases; the vagina in 68 cases. The lesion was situated at the margin of the anus in 33 cases; at the inter-crural angle in 5 cases; on the perineum in 7 cases; on the inner aspect of the thighs and upon the hypogastrium in 7 cases; on the cervix uteri alone in 1 case, and on the fourchette and cervix uteri together in 58 cases. Expressed in percentage, the extra-genital chancroids are only 6.05 per cent. of the total number of chancroids recorded, while of these none are cephalic (that is, occurring upon the head and face).

LOCALITIES OF SIMPLE VENEREAL ULCER AND OF INITIAL LESION OF SYPHILIS.

Table XV.

(Ricord, op. cit., p. 364.)

			Indurated chancre.	Simple chancre.
Patients affected with chancres of the glans and prepuce . . .			314	296
“ “ “ “ of the fossa glandis . . .			60	15
“ “ “ multiple chancres of the penis, that is, seated upon the prepuce and the fossa, the fossa and the glans, etc.			11	17
“ “ “ multiple chancres of the meatus urinarius . . .			32	9
“ “ “ intra-urethral chancre			17	3
“ “ “ chancres of the scrotum			7	0
“ “ “ “ of the peno-scrotal angle			4	0
“ “ “ “ of the anus			6	2
“ “ “ “ of the lips			12	0
“ “ “ “ of the tongue			3	0
“ “ “ “ of the nose			1	0
“ “ “ “ of the nasal mucous membrane			1	0
“ “ “ “ of the eyelid			1	0
“ “ “ “ of the fingers			1	1
“ “ “ “ of the leg			1	0
			471	343

Table XVI.

(Fournier, op. cit., p. 72.)

			Simple chancres.
Chancres of the glans and prepuce			347
“ “ fossa glandis			21
“ “ penis, that is, occupying at the same time the prepuce and the furrow, or the furrow and the glans			24
“ “ penis, no more precise designation			25
“ “ meatus urinarius			11
“ “ urethra			5
“ “ scrotum			3
“ “ pubes			3
“ “ internal and upper aspect of the thighs			2
“ “ anus			1
“ “ fingers			2
“ “ anterior thoracic region			1
			445

Table XVII.

(Debaugé, op. cit., pp. 62-63.)

		Simple chancres.
Chancres of the fourchette, or of the fossa navicularis		78
" " " or of the labi majora		19
" " " " minora		16
" " meatus urinarius (19 of these invaded the urethra)		1
" " vicinity of the meatus		2
" " vestibule		4
" " clitoris		1
" " introitus vaginæ st outside of the carunculæ myrtiliformes, between these and the labia minora		17
" " vagina posterior to carunculæ		7
" " cervix uteri		1
" " margin of anus		23
" " intercrural angle		5
" " perineum		5
" " internal aspect of thighs		5
" " hypogastrum		2
		206

Table XVIII.

(Males.)

(Sturgis, Records of Third Venereal Division, Charity Hospital, Blackwell's Island, New York, 1879-80.)

		Simple chancres.
Chancres of the prepuce		45
" " " and glans penis		14
" " penis (so stated in records)		5
" " meatus		2
" " sheath of penis		5
" " glans penis only		7
" " frænum		5
" " neighborhood of the meatus		2
" " meatus extending into the urethra		1
" " inner aspect of thigh		3
" " nates		1
" " scrotum		6
		96

Table XIX.

(Females.)

(Sturgis, Records of Third Venereal Division Charity Hospital, Blackwell's Island, New York, 1879-80.)

		Simple chancres.
Chancres of the labia majora		22
" " " minora		17
" " vulva, so stated in records		5
" " anus		8
" " neighborhood of the meatus		1
" " vagina inside of ostium vaginæ		9
" " vagina outside of ostium vaginæ		7
" " perineum		2
" " fourchette		12
		83

Table XX.

(Sims Perondi, quoted by and taken from Debaugé, op. cit., p. 63.)

		Simple chancres.
Chancres of the fourchette and cervix uteri		58
" " " alone		8
" " meatus urinarius		2
" " anus		2
" " vagina		28
		98

Résumé.

(1) Total number of chancroids recorded	. . . . .	1271
“ “ seated on genitals	. . . . .	1194
“ “ extra-genital	. . . . .	77
Of these latter none were found upon the head and face.		
(2) Total number of initial lesions recorded	. . . . .	471
“ “ seated on genitals	. . . . .	434
“ “ extra-genital	. . . . .	37
Percentage of genital chancroids to total number	. . . . .	93.95
“ extra-genital chancroids to total number	. . . . .	6.05
“ cephalic chancroids to extra-genital	. . . . .	0.00
“ genital initial lesions to total number	. . . . .	92.20
“ extra-genital initial lesions to total number	. . . . .	7.80
“ cephalic initial lesions to extra-genital	. . . . .	54.

On turning to the initial lesions, although we find the percentage of the extra-genital ulcers to be only slightly in excess of that of the chancroids (7.8 per cent. as compared with 6.05 per cent.), the percentage of cephalic to extra-genital lesions is very large, 54 per cent. Still, although I have been unable in my statistics to come across any cases of cephalic chancreoid, it would be unwise to conclude that they never occur, as several such have been reported. I do not here mean to include cases in which artificial inoculation of chancreoid matter has been successfully performed in the cephalic region; the only examples which I shall now consider are those which have been observed clinically.

The first positive case of the kind which I know of, is one given by Ricord,¹ with a plate, the history of which is a curious commentary upon the quotation on page 424, taken from his “Leçons.” It is quite short, and I give it here in full:—

“Primary and non-indurated ulceration of the upper gum. Here is a virulent and primary ulcer of the gum, contracted by the application of the mouth to the genital organs of a woman affected with chancre.

“It is the only example that we have met with, which proves that chancres of the gums are much more rare than virulent ulcerations of the lips and of the tongue, which we have had occasion to observe several times.

“This ulceration, of which the duration has not been very long, followed the ordinary course of the non-indurated chancre. It healed up under the influence of frequently repeated cauterizations with the nitrate of silver and of lotions of aromatic wine.

“Our object in calling attention to this case is to prove that the virulent, inoculable syphilitic pus has not, as its seat of predilection, any particular organ, but that it acts always at first locally, wherever it meets with the conditions favorable for its development. Moreover, the fact that in this patient there has been no constitutional infection, as we were able to determine long after the period at which it ought to have developed itself, proves that the gravity of syphilis does not depend, as has been said, upon the seat of the primary lesion.”

It should be remembered that, at this period of Ricord's teaching, he had not yet distinguished between the chancreoid and the initial lesion of syphilis, and that hence, in speaking of this lesion being syphilitic, he was in error, as he subsequently acknowledged. Although no auto-inoculation was practised, the history of the case and the appearance of the lesion in the plate leave no reasonable ground for doubting that the case was one of chancreoid of the gum. Still, Ricord is unwilling to admit that it was such a lesion, for he says, on the fifteenth page of his “Leçons sur le Chancre” (Paris, 1860):—

“These chancres (cephalic) always belong, and I might say inevitably, to but one species, the indurated. They are always accompanied by the symptoms of constitutional

¹ Clinique Iconographique, etc., pl. 21.

syphilis. Not one of them is exempt from induration, not one of them is confined to a local lesion without reaction upon the entire system, nor without phenomena of general infection. I shall not speak here of a case which I have published elsewhere. This case, which relates to a non-indurated chancre of the gum, would appear as a most conclusive exception, were it not for the fact that I have become more exacting in drawing conclusions than I was when I published the case. I repeat, that this case referred to a non-indurated chancre of the gum, which was not followed at the proper time by constitutional symptoms, and this chancre was derived from a woman who also had a chancre; but I ought to add that I did not see the woman, and that a knowledge of her disease was derived from the patient. I should also state that no artificial auto-inoculation was performed, hence the correctness of the diagnosis and the value of the case may very properly be doubted."¹

Fournier² gives the following case from Puche:—

A young man applied to Puche on the 17th of November, 1861, with an ulcer of the lower lip near the median line, which was chancreous in appearance, and had lasted three or four days. This ulcer came eight days after a connection, "the nature of which," as Puche says, "the patient did not attempt to deny." There was a slight adenitis of the submental gland. The patient was taken to Cullerier for an opinion, which was "indurated chancre." Puche, dissatisfied apparently with this diagnosis, practised auto-inoculation with the secretion of the ulcer on the man's abdomen. While the inoculation was being made, the patient, attempting to restrain the surgeon's hand, pricked himself on the finger with the instrument. The result in both places was positive in a few days. Local treatment was now instituted, and all three ulcers healed without induration, and the patient passed from observation on the 31st of December, 1861, without any constitutional symptoms of syphilis.

The history of this case it would be hard to controvert, and unless we are prepared to entirely abandon the value of auto-inoculation in diagnosis, we must be willing to admit that this was an undoubted case of chancreoid of the lip. I know that the experiments that have been made with simple pus would seem to rob this case of many of its distinctive features in a diagnostic point of view, but when we consider that these ulcers have been artificially inoculated upon the face by many trustworthy observers, it would, I think, be a refinement of criticism to deny that this case was one of true chancreoid of the lip.

Diday³ gives two separate cases of what he calls "chancrelles de la bouche," and MM. Boys de Loury and Costilles⁴ give two more cases, one of the eyelid and one of the ear, but these cases are so imperfect as to be worthless, and I shall make no further mention of them.

Millet, in his thesis, gives a curious though somewhat imperfect account of a man who on the 12th of July, 1865, went bathing in a forbidden locality, was chased by the police, and was in the water for two hours. When he came out he was very much exhausted and had violent lumbar pains. On the 13th, he went to the Hôpital St. Antoine, where he was confined to bed for fourteen days, during which time he saw no outside friend but his mistress. On the 28th, the day after leaving the hospital, he noticed a smarting of the lower lip, on the skin and mucous membrane of which were some small yellow pimples. The next day these pimples were covered over with a crust. Thinking he had some venereal affection, although he declared that his mistress was perfectly healthy, he went to the Hôpital du Midi on the first day of August.

¹ Ricord, in his "Traité pratique des Maladies Vénériennes," published in 1838, gave in his tables of inoculations seven cases of primary syphilis on the lips, and three in the throat, all of which produced the characteristic pustule of inoculation, as among the cases which occurred in his wards in 1831 and 1837. As no details are given, the cases are worthless in a scientific point of view.

² Nouveau Dictionnaire de Médecine et de Chirurgie Pratiques. Art. Chancre.

³ L'Union Médicale, 1858; and Annales de Dermatologie et Syphiligraphie, 1872, No. 2.

⁴ Gazette Médicale de Paris, 1845, 1847.

On his entrance the following condition of things was observed. Smarting of the lower lip which was found swollen, patulous, and devoid of induration. The mucous membrane was deep red in color, and glistening. On the mucous surface of the lower lip, near the gingivo-labial fold, was a chancreous-looking ulceration, and on the cutaneous surface covered by the beard, were two small ulcers covered with crusts. His teeth were good, but dirty and uncared for. (He was a great smoker.) The mouth and pharynx were sound. A submaxillary lymphatic gland, in the median line, was enlarged to the size of a pigeon's egg, and painful on pressure. Abundant salivation was present, but the breath was not fetid. There was no pain in the lip except on mastication. The last coitus, according to his statement, had taken place on the 10th of July. On the 2d of August, inoculation was made with matter taken from the ulcer on the inside of the lip, and this inoculation was positive in result. The resulting sore lasted for fifteen days, and disappeared without treatment, while the ulcers of the lip healed under the local use of chlorate of potassium. The submaxillary ganglion did not suppurate.

Millet himself seems to doubt whether this lesion was really a chancreoid, and he says that its value is impaired by two circumstances: the first is that he did not have permission to examine or even question the man's mistress; and the second, that the pus of ulcerative stomatitis has been proved auto-inoculable in several instances by M. Bergeron, of the Hôpital Sainte Eugénie.¹

The next case is one reported by Labarthe.²

It occurred in a man who applied for treatment on the 4th of December, 1870, with three chancreoids of the penis and a right inguinal adenitis attended with fluctuation. The bubo was opened on the same day, and local treatment was pursued for both sets of lesions. On the 8th of December, the patient called the doctor's attention to his lower lip, which pained him. There, at a point midway between the median line and the left commissure, was a longitudinal ulceration which had the appearance of a deep fissure. The edges, however, were punched out and a little undermined; the floor was grayish in appearance, and furnished a purulent secretion. Upon questioning the man, it appeared that he was in the habit of placing the pin which confined the dressing of his bubo between his lips. Labarthe believed that he had to do with a chancreoid of the lip, but to make assurance double-sure, he inoculated the matter from the ulcer on the man's lip, above his abdomen, and in four days the result was positive.

The next cases are those of Profeta, of Palermo, which are translated from the Italian in the fifth volume of the *Annales de Dermatologie et de Syphiligraphie*.

The *first* case was that of an Italian musician, whose chancreoid, of two years' duration, began at the right commissure of the lips, and extended over the cheek and forehead. It was phagedænic in nature, and was seated upon an engorged but not indurated base; it secreted an abundant purulent matter; its edges were livid and undermined; in short, it presented all the aspects of a phagedænic chancreoid. No evidences of constitutional syphilis were present, but the patient had a vesiculo-pustular eruption due to the presence of the *acarus scabiei*. Auto-inoculation was practised with the pus of this ulcer, with a positive result.

The *second* case was one of a barber who had multiple chancreoids of the penis, with a suppurating bubo. Attempting to open this bubo with a razor, he cut his finger, soiling the wound with pus and blood from the bubo. He then promptly put his finger in his mouth to stanch the bleeding, and the following condition of things ensued. He had a chancreoid of the index finger of the left hand, with lymphatic engorgement of the arm of the same side; besides this, he had two chancreoidal ulcerations of the upper and lower lips, which invaded both the skin and mucous tissues of these parts. He apparently declined treatment, but Profeta saw him from time to time for a year, and states that his face was peppered (parsemé) with chancreoids.

¹ De la Stomatite ulcéreuse. Paris, 1860.

² Le Chancre simple, Thèse, p. 53.

The *third* case was one of phagedænic chaneroid of the penis, this latter being almost entirely destroyed by the ulceration. There were also a chaneroid of the scrotum, and an ulceration seated upon the right ala nasi which bore all the characteristics of a chaneroid. This latter chaneroid inoculated the tissues about the nose, and finally became phagedænic and produced great destruction of those parts. Although this ulcer improved under treatment, the patient disappeared from Profeta's sight before cicatrization was complete.

In this third case, auto-inoculation was not resorted to, and hence doubt might arise whether this were not an ulcerating serpiginous syphilide of the face and of the body, although no history of syphilis is given; but with the first two cases, I think no reasonable doubt can exist, if we concede the existence of such a thing as a chaneroid.

Profeta's fourth case is reported in the *Gazette Médicale de Lyon*, for 1867, and was a serpiginous chaneroid of two years' duration, which was seated upon the face. Profeta inoculated himself with the pus of the chaneroid in five places, producing five chaneroids which were not, in the space of eighteen months, followed by constitutional syphilis.

Dr. R. W. Taylor,¹ of New York, reports a case which occurred in his own practice at the New York Dispensary.

A man with chaneroids of the prepuce inoculated himself over the outer margin of the left supra-orbital ridge with the pus from his chaneroids, producing an ulceration which had all the appearances of a chaneroid. Matter from this supra-orbital ulcer was inoculated upon the man's abdomen, care being taken to prevent contamination with the matter from the chaneroids of the penis, and in four days afterwards a positive result was obtained.

Apart from these cases of accidental inoculation, artificial inoculations have been resorted to by Bassereau, Puche, Rollet, Hubbenet, and others, which conclusively prove the possibility of inoculating chaneroidal pus upon the face. It has been stated that one peculiarity of cephalic chaneroids is that they are short-lived, but upon reviewing the cases on record this point is not to my mind satisfactorily proved. Enough cases have been reported to show that the cephalic region is not exempt from being the possible seat of a chaneroid. Such ulcerations are, it is true, not common in this region, and hence we may lay down the general law that ulcerations of this portion of the body should be regarded with suspicion, and should be considered as syphilitic, unless the contrary can be distinctly proved.

ORIGIN OF THE SIMPLE VENEREAL ULCER.

As already stated, Clere, in 1854, considered that the chaneroid was the result of inoculation of the matter of an indurated chancre upon a person who either was suffering or had suffered from constitutional syphilis. Since Clere's time, however, this doctrine has fallen somewhat into discredit, and until within a short period it has generally been believed that the chaneroid and the chancre were produced by two distinct kinds of virus, and that it was not possible to produce a chaneroid by any other means than by contact of a chaneroid or a chaneroidal bubo. Here is another instance of the error produced by this word "*virus*," a term which I trust will be expunged in time from the venereal vocabulary. We have already seen that it is possible to produce a sore corresponding in many points with a chaneroid from the inoculation of simple pus, and if these experiments be trustworthy, then it is the pus-corpuscle which is the cause of the ulcer (chaneroid), and not any supposititious

¹ Archives of Practical Medicine, 1873.

virus. Let us see if the same thing can be done with the secretion of syphilis, and under what conditions success is obtained.

In 1854, M. Maratray (de Nevers) published a case¹ which is very interesting and instructive.

"During September, 1852, one of my friends, who was syphilitic at the time, consulted me as to the nature of an ulceration situated upon the frænum, dependent, so he said, upon a coitus dating twelve days back. At a glance I recognized a specific ulceration with a tendency to become phagedenic. He informed me that another young man who upon the same day had had connection with the same woman, was suffering with a less painful and less extensive ulceration. Upon examination of this young man, I recognized upon him an indurated chancre accompanied with a perfectly well characterized inguinal adenitis, one of the most certain signs of constitutional infection. I asked if it were possible to see the presumed cause of the trouble. Frightened by the word "*pox*," she consented to an examination. My attention was attracted at first to the fourchette, the seat by predilection of chancres in the woman, and this the more on account of the strange coincidence of the ulcer of the frænum in the man. I at once discovered a specific ulceration in process of repair; palpation showed a hard, cartilaginous, elastic nodule, which by compression blanched the neighboring tissues. All the characteristics of the indurated chancre were present; there was no possibility of mistake; the inguinal ganglia, although somewhat difficult to recognize, were yet perceptible by comparison with those of the unaffected side. In spite of great care, further research failed to reveal in any portion of this woman's genitals, whether in the vagina or the neck of the uterus, any reason for the existence of the phagedænic chancre. As the good hygienic conditions under which the first patient was placed compensated somewhat for the debilitating influence of the syphilis, a local dressing of aromatic wine led to a pretty prompt cure. As to the two indurated chancres, as already stated, cicatrization had commenced, and went on to completion. I learnt subsequently that secondary symptoms appeared in the man and in the woman notwithstanding a mercurial treatment of some duration."

This case was followed, in 1856, by the two following, mentioned by Ricord and quoted by Fournier.²

CASE I.—One of my old patients, whom I had treated several months during my service in 1843 for an indurated chancre, followed by constitutional manifestations—roseola, mucous patches of the mouth, posterior cervical adenitis, alopecia, etc.—had connection with a woman of the town during May, 1856. It was at least two months before this time since the patient had seen another woman. Some days after this connection, two chancres appeared upon the prepuce, one upon the cutaneous, the other upon the mucous, surface. The patient at first pursued no treatment. When I examined him, the chancres were of ten days' duration, the size of a ten-cent piece, without any induration of the base—indeed, they were quite supple and exempt from inflammation. The glands of the left groin were slightly swollen and painful. The diagnosis was beyond question. I had to deal with simple chancres, at least as far as their external characters were concerned. They healed up, without complications, under simple dressings of aromatic wine. The adenitis rapidly disappeared. No internal treatment was used, but the patient, kept under careful observation, has not presented any new symptom of syphilis. While this patient was being treated at the *Midi*, my *interne* looked up and found the woman who was pointed out as the source of the man's disease. What do you suppose was found? A typical indurated chancre of the labium majus, with an enormous chondroid induration. This chancre, according to the patient, had existed for several weeks. It was accompanied by a well-marked adenitis, and was followed by subsequent constitutional manifestations.

CASE II.—L., a girl seventeen years of age, was infected in June, 1856, with an indurated chancre, accompanied by an inguinal adenitis, in which the glands were multiple, hard, and indolent. She followed a mercurial treatment for only a few weeks' time. In September, a confluent roseola covered her body, the hair began to come out, and a double cervical adenitis showed itself. There could be no question as to the dis-

¹ Op. cit., p. 49 *et seq.*

² Recherches sur la Contagion du Chancre.

ease in this case. During the last of June, one of my former patients, whom I had treated in 1842 for an infecting chancre followed by constitutional symptoms, had connection with this girl, and contracted two chancres on the penis, one at the frænum, the other on the prepuce. These two chancres were entirely devoid of induration; their bases remained supple. The inguinal ganglia were not affected, and, although no specific treatment was employed, constitutional manifestations did not appear.

Ricord considered both these cases as simple chancres (that is, chancreoids), produced by the secretion of an indurated chancre (initial lesion of syphilis) upon a person previously syphilitic. But another explanation of these two cases may be given. A double infection (what Rollet called a mixed sore) may have existed in the woman; she may have had both a chancreoid and syphilis at the same time. Each following the laws of its existence, the chancreoid would appear first. The men, having coitus at that time—and there is nothing in the histories to disprove this supposition—before the syphilis made its appearance, would naturally contract only a chancreoid; the woman, seen when her chancreoid had gone, and when the initial lesion had appeared upon the scene, would be unquestionably syphilitic; and the deduction being drawn that the secretion of the initial lesion had produced a chancreoid, error and confusion would follow.

Let us see if any other cases have been reported which will assist us in our search.

H. Rey¹ reports a most extraordinary case, which is briefly as follows:—

Two young men, A. and B., free from any previous syphilis, have connection on the same day with the same woman, C. From ten to fifteen days (sic) after, A. calls upon M. Rey, and shows him an indurated chancre with inguinal adenitis. A few days subsequently B. calls upon M. Rey, and shows him four chancreoids of the penis, with an inflammatory mono-glandular adenitis. C. is then examined. She has an indurated chancre at the fourchette, with double syphilitic adenitis. The sequel in the three persons is, that A. has cervical adenitis and mucous patches in the throat; B. has a suppurating bubo, this and the chancreoid finally heal under local remedies only, and no constitutional manifestations appear within six and a half months after cicatrization of the chancreoid; C. has a macular syphilide.

What shall be said of this case of M. Rey? Let us run over the points: Two men, A. and B., entirely free from syphilis, cohabit on the same day with the same woman, C. She has "*un chancre induré magnifique*." What is the result? One, A., contracts syphilis—just what we should expect; but the other, B., contracts chancreoids—what we should not expect. Why? Inexplicable, unless this happened: B. followed A. directly in coitus; the excitement and stimulation of A.'s coitus caused the woman's initial lesion to suppurate, and the pus thus produced was inflammatory and capable of inoculation, not as syphilis, but as a local ulcer (chancreoid). This is pure hypothesis, because, although we have the records of many cases of auto-inoculation of *irritated* initial lesions, there are none, as far as I know, of inoculations with such matter of irritation on subjects free from syphilis, and until this is done the problem must go unsolved.²

But though we have not any cases exactly corresponding to the conditions above named, there is one, published by Robert,³ which presents us with a very interesting experiment indirectly bearing upon this subject:—

Madame J. was affected with two cancerous ulcerations of the nose, the largest of which was the size of a franc piece (quarter dollar).

¹ Annuaire de la Syphilis, 1858.

² In this connection, consult Lee, Lectures on Syphilitic and Vaccino-Syphilitic Inoculations. London, 1863; Boeck, Recherches sur la Syphilis. Christiania, 1862; Danielssen, Deutsche Klinik, No. 33, 1858, etc.

³ Nouveau Traité des Maladies Vénériennes. Paris, 1861. This case has been given more fully on page 305, to establish another point.

October 14. The more extensive ulceration was dressed with a dossil of lint soaked in the pus taken from a recent chancre of inoculation practised upon a syphilitic patient; this chancre was derived from a simple ulceration.

October 16-25. The peripheric inflammation has increased; the ulceration has extended. The floor of the ulcer is gray; its scalloped borders are undermined. Suppuration is very abundant, and the patient complains of a decided heat and tingling in the part. No glandular enlargement.

November 1. Ulcer is evidently transformed into a chancre.

December 15. The wound which was inoculated and partially cicatrized was dressed with aromatic wine. No signs of adenitis and no signs of infection.

December 27. The ulcer of inoculation, as well as the second cancerous ulceration, had both entirely healed. There was no sign of any constitutional infection. The dressings had been diachylon at first, and afterwards aromatic wine.

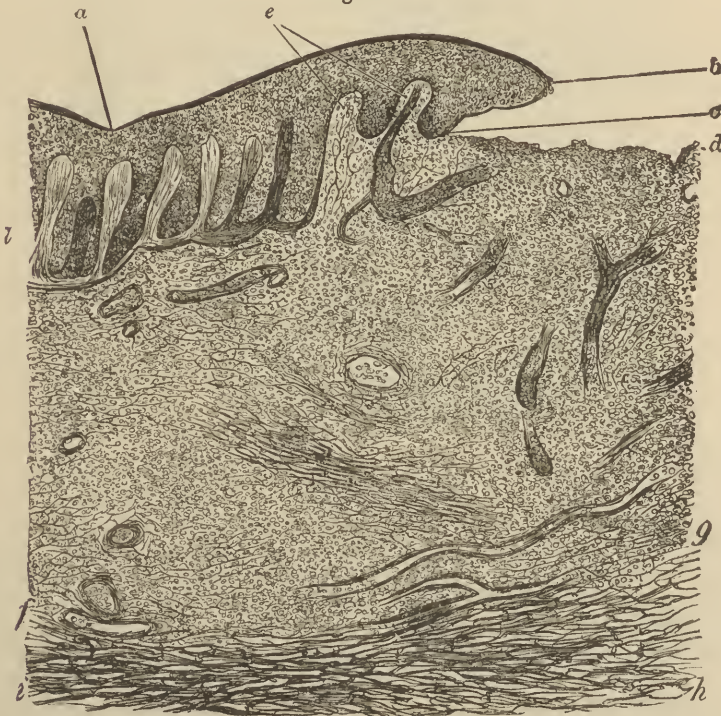
So far, then, no cases have been published, or are known, which prove the direct descent of the chancreoid from syphilis, as those which I have presented (the only cases I can find upon this branch of the subject) are all open to serious question.

Of course, it would be idle to speculate upon the possibility of future experiment proving this derivation, so that we must at present content ourselves with saying that *the simple venereal ulcer (chancreoid) is derived from the secretion of another chancreoid, or of a virulent (chancreoid) bubo, and from nothing else.* Nor does the possibility of simple pus being auto-inoculable deprive this fact of any of its importance.

ANATOMY OF THE SIMPLE VENEREAL ULCER.

But little has been written upon this subject, and most of our knowledge of the pathology of the chancreoid is derived from the works of German

Fig. 331.



Section made through a soft chancre [chancreoid]. Hartnack, oc. 3, obj. 4. (Kaposi.)

observers. Kaposi¹ and Caspary² are the most recent writers upon this subject, and as Kaposi's description is the best, I shall give it in full:—

Microscopical examination of a perpendicular section, including the margin, the inflamed parts in the neighborhood, together with a portion of the floor and the inflamed base of the ulcer, shows that a portion of the skin occupied by the chancreoid consists of two parts, which have evidently undergone different anatomical changes. (Fig. 331.)

From the floor of the ulcer, *c d*, to a considerable depth in the corium is a uniform and uncommonly thick cell infiltration which terminates sharply at the line *f g*. This infiltration is continued beneath the intact papillæ of the margin of the ulcer, *e l*, and laterally far beyond the limits of its floor. The tissue bordering on the infiltrated

Fig. 332.



Section made through a soft chancre [chancroid]. Hartnack, oc. 3, obj. 7. (Kaposi.)

mass, *f g h i*, is composed of loose meshes, and exhibits scattered cells with a large nucleus, which is well brought out by carmine. In the swollen margin, *a b*, a number of papillæ, *e*, lying nearest to the floor of the ulcer are thickened and closely infiltrated with cells. The layer of Malpighian cells between these papillæ is thickened. These, *b*, overhang (undermining) the walls of the ulcer. The floor of the ulcer, *c d*, is formed by the exposed cell-infiltrated corium and is destitute of papillæ. Both the corium and

¹ Syphilis der Haut und der angrenzenden Schleimhäute. Wien, 1873.

² Zur Anatomie des Ulcus durum und molle. Vierteljahrsschrift für Dermatologie und Syphilis, 1876.

papillæ, wherever infiltrated with cells, exhibit numerous enlarged vessels, most of which are bloodvessels. A few, however, are lymphatics.

With a higher power (Fig. 332), the cell-infiltrated portion, *a b d*, consists of a close network of partly narrow, and partly broad bundles of fibres with faint contours, in which is deposited an abundance of nucleated and evenly distributed cells, some of them very large and resembling lymph corpuscles, others smaller. The cells lying near the floor of the ulcer and the neighboring parts are for the most part small and irregular in outline, with scattered nuclei. Free nuclei and nucleoli are also found in large numbers. In the deeper tissues, the cells have generally the appearance of inflammation-corpuscles, but there are also many smaller ones. Of great interest is the remarkable thickening of the walls of the vessels, *e d g*, which appear to be embedded in an abundant network of tissue-proliferation, due to adventitious fibrous deposits running parallel to them. In this network, cells with large nuclei are found. The openings of the vessels are everywhere apparent throughout this cell-infiltrated tissue, inasmuch as they are kept dilated by the surrounding œdema. The degeneration of the tissues and of the infiltrated cells takes place only in the upper portion, and to an extent which is only limited by the extent and depth of the infiltration. Interstitial abscesses do not exist. We have not found any characteristics which would enable us to distinguish the cell-infiltration of the corium and the papillæ, or the subsequent degeneration of the same, from similar processes of simple origin.

COMPLICATIONS OF THE SIMPLE VENEREAL ULCER.

The complications which occur with this variety of ulcer are numerous, and the acuter the inflammation the more likely are they to occur.

BUBO.—That most frequently met with is the bubo, and this is of two kinds, the “*simple*,” which is sympathetic in nature, and is really nothing but a glandular or peri-glandular abscess, which secretes healthy pus and heals up rapidly as soon as its contents are evacuated; the other the “*virulent*,” which is always serious, depending upon the absorption of the chancroidal matter by the lymphatics, and its arrest and retention in the nearest chain of glands, there to produce an inflammatory and contagious ulceration of the gland similar to that which gave rise to the bubo.

As showing the relative frequency with which various complications occur in cases of simple venereal ulcer, I refer the reader to the annexed table, in which will be found the figures bearing upon this subject. In 200 cases

FREQUENCY OF COMPLICATIONS IN SIMPLE VENEREAL ULCERS.

Table XXI.

(Sturgis, Records of N. Y. Dispensary for the last four months of 1879, Division F.)

Patients with chancroids recorded	200
“ without complications	135
“ with	65
buboes (non-suppurating)	22
phimosis	21
gonorrhœa	17
balano-posthitis	5

taken from the records of the New York Dispensary for the last four months of 1879, it will be seen that complications occurred in 65, or in about one-third of the cases, and that of these 65 patients who presented complications, 22, or nearly one-third, suffered from buboes, while phimosis, gonorrhœa, and balano-posthitis made up the remaining two-thirds. The bubo then we may accept as the most frequent complication found with chancroids, and the next question for consideration is whether buboes are usually mono-lateral or

bi-lateral. On looking at the first of the appended tables, we observe that 71 patients were the bearers of buboes, 54 having but a single bubo, while 17 had bubo on both sides; this is accounted for by the fact that the bubo is generally mono-lateral unless the ulcer is seated upon, or close to, the frænum of the penis, when both groins are attacked, and that chancroids of the frænum are not as often met with as chancroids of other portions of the genital mucous membrane. (See Table XVIII. page 320.)

FREQUENCY OF BUBO IN CASES OF SIMPLE VENEREAL ULCER.

Table XXII.

(Sturgis, Records of Third Venereal Division Charity Hospital, B. I., N. Y., 1879-80.)

Patients affected with simple venereal ulcers	249
Without bubo	178
With buboes	71
Of these—with single bubo	54
with double buboes	17

Table XXIII.

(Ricord, op. cit., p. 40.)

Patients affected with simple chancres	207
“ “ “ buboes	65
“ without buboes	142

Table XXIV.

(Sturgis, Records Third Venereal Division, Charity Hospital, B. I., N. Y., 1879-80.)

Total number of buboes	71
Suppurating buboes	30
Non-suppurating buboes	41

Résumé.

Total number of patients recorded	456
“ “ with buboes	136
“ “ without buboes	320
Percentage of patients with buboes to total number, almost	30
Total number of buboes (see Table XXIV.)	71
Percentage of suppurating buboes to total number of buboes (Table XXIV.)	42.2

As regards the pathology of this kind of bubo, it may be repeated that there are two kinds, viz., the sympathetic bubo, and that resulting from absorption. The first symptom noted by the patient is a feeling of pain and uneasiness in one or both groins, aggravated by motion, and upon examination the surgeon readily detects a swollen and painful gland or glands. This enlargement differs materially from the adenitis found in syphilis, in that the gland is not felt distinct and separate from the surrounding tissues, but is sunk into and matted together with the material of inflammation, infiltration and cell exudation; that the outlines are indistinct; and that the swelling interferes with motion. At first, redness is absent, but in a short time this symptom supervenes, and invades the entire swelling. After lasting a longer or shorter time, a point of softening declares itself at the apex of the swelling, and fluctuation is apparent on palpation. Up to this point, both kinds of bubo run the same course, and there is no means of deciding to which class the swelling belongs. As soon as fluctuation is certain, the wisest course is to open the bubo, and for these reasons: it is a good, fundamental rule in surgery to evacuate pus wherever practicable; the bubo, if simple, heals more rapidly if it be opened, while if it is “virulent,” it becomes of decided importance to open it—in the first place, to prevent burrowing, and in the next, to check the destructive action which is always present in these

lesions, and which constitutes a very dangerous element. These buboes, when left to themselves, always sooner or later* slough, but sometimes not until they have undermined the skin to an alarming extent; hence it is good surgery under any circumstances to open a bubo in which fluctuation is evident.

The bubo after it is opened diverges widely in its future course according to its nature. The *simple bubo* reveals itself as an ordinary abscess with a clean, healthy-looking floor and edges; it secretes laudable pus, the granulations are red, and bleed easily upon handling, and the wound heals rapidly. The *bubo by absorption*, on the other hand, presents the appearance of a chancre, which, indeed, it is; the floor is uneven, irregular, unhealthy-looking, covered with a dirty-grayish or yellow pultaceous layer, which is adherent to the ulcer; the edges are undermined for some little distance from the edge of the ulcer, and the overlying skin is dead and shrivelled; the discharge, which is copious, is grayish or brown, sanious, and irritating, differing widely from healthy pus, and healthy granulations are absent. Unless checked by proper treatment the ulceration extends rapidly, destroying tissue and burrowing deeply in the groin, down the thighs, and even up the abdominal walls, not infrequently giving rise to alarming hemorrhage from erosion of the superficial epigastric and femoral arteries.

The other complications liable to occur with the simple venereal ulcer are Phimosis, Paraphimosis, Balanitis, and Phagedæna.

PHIMOSIS AND PARAPHIMOSIS.—These complications are only serious if aggravated by intense inflammation, when they produce gangrene from impediment to the proper nutrition of the part. In *phimosis* the skin of the penis becomes enormously œdematous, the prepuce cannot be retracted, and the discharge from beneath the foreskin becomes often so abundant as to give rise to doubt whether the case may not be one of gonorrhœa instead of chancre. Auto-inoculation here comes to our rescue, and if the experiment be successful, all doubt will be ended as to whether the surgeon has a gonorrhœa or a chancre to deal with, for the secretion of gonorrhœa is incapable of auto-inoculation. If, on the other hand, the experiment is unsuccessful, the probabilities will be in favor of the concealed disease being simply a clap, and this point is of importance in regard to treatment, inasmuch as in the latter event incisions may be resorted to for the relief of the phimosis, which the surgeon would hesitate to use if the concealed disease were chancre.

In *paraphimosis* the diagnosis is much easier, as the parts are more exposed to view, and the only question to occupy the surgeon is the prevention of gangrene.

BALANITIS is not an infrequent concomitant of chancroids, and is more annoying than serious, the abrasions becoming converted into chancreoid ulcers, which have a tendency to run together into one large sore.

PHAGEDÆNA.—Besides the complications hitherto considered there is one other, by far the most serious which can befall. I mean *Phagedæna*. This occurs in consequence of some constitutional defect, such as Tuberculosis or Scrofula, or from a vitiated condition of the system—as, for example, alcoholism—and not from any inherent vice in the ulcer, or in the inflammation attendant upon the chancreoid itself. When this is attacked by phagedæna, a notable change occurs in its character and local aspect. The pus, which formerly was abundant and fairly purulent, now becomes scanty and thin; its color changes from yellow to brown, sometimes even to black, from the detritus of tissue; the floor of the ulcer becomes of a leaden-gray, brown, or black

hue, and is converted into a thick, grumous, pultaceous mass; the undermined edges of the sore collapse, while simultaneously fresh burrowing goes on, extending the area of the wound to an alarming extent. Sometimes an attempt at cicatrization takes place at one end of the ulcer, while rapid progress is being made at the other; and when this assumes a sinuous course the affection is known by the name of the "*Serpiginous Phagedænic Chaneroid*." At other times, the floor of the ulcer is overspread with a grayish flocculent membrane, not unlike the diphtheritic membrane, which is closely adherent to the sore. This goes by the name of the "*Diphtheritic Chaneroid*." The odor emanating from such ulcers is sickening, and the patient, exhausted by this constant suppuration and necrosis of tissue, assisted sometimes by hemorrhage as bloodvessels are eroded by ulcerative action, is often reduced to an alarming condition of debility.

Under appropriate treatment the phagedæna sometimes disappears, when the ulcer assumes the appearance of a simple granulating wound, and finally heals, but often at the expense of serious loss of tissue, leaving as a reminder of its presence an indelible scar. But this happy result is not always attained, for sometimes the ulcer obstinately refuses to heal under the most approved treatment, and remains in an indolent, unhealthy condition, the floor being covered with a grayish exudation, and the few granulations that spring up being flabby and easily destroyed. In this condition the ulcer will sometimes remain for a longer or shorter time, until excited into action by some accidental cause, when suddenly the activity of the disease will be renewed, the phagedænic ulceration will extend with frightful rapidity, and severe loss of tissue will ensue. This renewed activity will after a while subside, and the ulcer will then relapse into its former indolent condition, until again excited into activity. These "*Chronic Chaneroids*" are practically incurable, and the patient finally succumbs from exhaustion, and, as I believe is often the case, from an associated phthisis. I have observed during my hospital experience many such cases, and although I am not yet prepared to say absolutely that phthisis was the cause of incurability of the ulcer, I believe that it played an important part in that direction.

MIXED CHANCRE.—There is another condition of things occurring with the chaneroid which can hardly be called a complication, but which is full of interest and worthy of mention. I allude to the so-called "mixed chancre" of Rollet, the invention of which was a happy stroke of genius to account for certain ulcers which, although undoubtedly chaneroidal in the beginning of their career, in due time became converted into initial lesions, and were followed by other symptoms of syphilis. In consequence of the name, much confusion arose from the belief that a real admixture of the two kinds of virus took place, and that the secretion of this ulcer would by inoculation produce a sore which, although chaneroidal at first in all respects, would become syphilitic, and be followed by the subsequent manifestations upon the skin and mucous membranes. Such, however, has been found by experience not to be invariably the case; and in those instances in which the occurrence did take place, it was due to the period at which the sore whence the matter for inoculation was taken had arrived.

Thus, if the matter was used when the sore was still young, that is, within the first fourteen days of its existence, the inoculated ulcer was and remained throughout a chaneroid; if, however, the matter was taken between the fourteenth and the twenty-first days, then the resulting ulcer would often start as a chaneroid and end as an initial lesion; but when the matter was not taken until the sore was twenty-one or more days old, then no chaneroid would appear, but the resulting inoculation would be from the beginning an initial

lesion. In other words, there was a commingling of two kinds of poison; what did occur was a double infection at the same spot—possibly, not necessarily, at the same coitus—and, each disease following its own natural course, the first to appear would be the chancre, and after that, at the proper time, the syphilis embodied in the initial lesion. Each disease, to parody the well-known maxim in the old Roman policy, “divide et impera,” pursues its own course undisturbed by the other, as far as it is possible to do so, but the syphilis, as the more chronic affection, naturally outlives the chancre.

DIAGNOSIS OF THE SIMPLE VENEREAL ULCER.

To repeat what was said before when discussing the gross appearances of the chaneroid, the diagnosis of this variety of ulcer is based upon the following points:—

(1) An *absence of incubation*. The chancreoid appears usually within the first eight days after the infecting coitus, and probably in a large proportion of cases even earlier. (See *Résumé* of Tables XI.-XIV., page 317.)

(2) The property of *auto-inoculation*. This consists in a capacity for reproduction within certain limits from the secretion of the original ulcer. Owing to this property, this variety of sore is more often multiple than single. (See *Résumé* of Tables V.-X., page 315.)

(3) The *absence of induration* of the base. This point, it is true, has lost some of its significance since the discovery of the fact that the initial lesion of syphilis is occasionally met with devoid of induration. Nevertheless, should this point be doubtful, other symptoms must be appealed to in order to establish the diagnosis. The pseudo-induration of the simple venereal ulcer must also be rated by the same standard.

(4) The *copious purulent secretion*. This is due to the inflammatory and destructive nature of the sore.

(5) The *punched-out* and *undermined edges* of the sore.

(6) The *irregular* and *eroded* appearance of the *floor*.

(7) The *grayish-yellow layer* covering the floor of the ulcer. These three last are all due to or result from inflammation.

RELATIVE FREQUENCY OF SIMPLE VENEREAL ULCER AND INITIAL LESION
OF SYPHILIS.

Table XXV.

(Ricord, op. cit., p. 10.)

Total number of patients	10,000
“ affected with simple chancres	8,045
“ “ “ infecting chancres	1,955

Table XXVI.

(Fournier, *ibid.*, p. 9.)

[illegible]

Table XXVII.

(Chabalier, Historique de la pluralité des Maladies Vénériennes. Thèse. Paris, 1860.)

[illegible]

PROGNOSIS OF THE SIMPLE VENEREAL ULCER.

Generally speaking, this may be said to be favorable, the large majority of chancreoids healing rapidly without leaving any bad results behind, either in the way of systemic infection (for the disease is purely local, never constitutional), or from serious destruction of tissue. But to this, as to all rules, there are exceptions, and these usually occur when the chancreoid is attacked by phagedæna. In such a case, the destruction is often frightful, and the incurability of the ulcer, the exhaustion which it induces, and the serious hemorrhages to which it gives rise, not infrequently tend to a fatal termination. Such cases are happily rare, at least among our white population, the fatal cases which I have seen having occurred in the dark-skinned races: indeed, I have often been struck with the peculiarly rebellious and alarming course which venereal diseases, particularly chancreoid and syphilis, pursue among the negroes and Chinese. The same peculiarity I am told exists among the Mexicans, especially in those persons who have an admixture of negro or of Indian blood.

TREATMENT OF THE SIMPLE VENEREAL ULCER.

Under this heading, I shall first consider the treatment of the uncomplicated chancreoid, and shall afterwards take up the various complications. In the treatment of all chancreoids, two indications must be steadily kept in view: the first is to prevent the extension of the ulceration and to relieve the inflammation; the second, to prevent the conveyance of the matter to adjacent or to distant tissues, and thus to obviate the production of fresh sores.

Now, as to the first point:—to prevent the extension of the ulceration and to relieve the inflammation. The best method of obtaining this result is the destruction of the ulcerated surface, and especially if it be large and progressive, by some active cauterizing agent which shall so change the nature of the ulcer as to cause it to heal up instead of extending—what in ordinary parlance is known as “destroying the virus.” The best agent for this purpose is the actual cautery, the iron being heated to a white heat, the galvanocautery, or the Paquelin cautery, either one of which is sufficient to change the character of the sore. This form of cauterization is best adapted to seriginous, diphtheritic, and phagedænic sores, where extension is rapid and destruction serious; for the milder varieties, some less powerful caustic is sufficient. Of these, chemically pure sulphuric acid takes the lead for the thoroughness with which it destroys the ulceration; next to this come caustic potassa, chemically pure nitric and carbolic acids, then iodine and bromine, and, last of all, the nitrate of silver, which cannot properly be called a caustic, its action being so superficial as to give it the character of a stimulating rather than that of a destructive agent.

Many surgeons of the present day deprecate the use of caustic or destructive agents for the treatment of the majority of chancreoids met with in practice, declaring that milder and less heroic measures suffice for the cure. Undoubtedly this is perfectly true, a large proportion of the simple venereal sores met with at the present day being of the mild and superficial variety, which will heal up under the use of iodoform or some such simple remedy. But the advantage of using a cauterizing agent, as long as the sore retains the appearances of inflammation and unhealthy action, is that for this condition of things it substitutes a healthy action, and obviates what not infrequently happens in chancreoids, viz., a supervention of inflammation in what

originally was a superficial and mild ulceration. Besides this, a proper use of the cautery hastens the cure, and any means which does this should be used, no matter though it may not appear absolutely requisite.

APPLICATION OF CAUSTICS.—If caustics are to be applied, certain points should be carefully attended to in order to make their use effective. Selecting the one which is most active, it should be applied not only to the apparent surface of the sore, but should be carried beneath its edges, and into sound tissue to the extent of from an eighth to a sixth of an inch, or further, if the undermining process is extensive; in other words, the entire extent of the ulceration must be thoroughly destroyed, else the healthy ulcer left after the cautery is apt to become contaminated with the matter from those portions which have not felt its action, and the inflammation then commences anew, and spreads over a broader area. The old remedies known as Ricord's and Canquoin's pastes have lately fallen into disuse, and their employment presents no advantages over simply cauterizing the ulcer with the liquid caustic, and applying cold water dressings, while it has the decided *disadvantage* of concealing the chancroid from view, and thus preventing the surgeon from knowing what is going on beneath the crust which is formed. The simpler and more effective is the agent employed, and the more accessible is the ulcer to the inspection of the surgeon, the speedier will a cure be brought about, inasmuch as the applications may then be made with sufficient frequency to insure the substitution of a healthy action for the morbid inflammation.

SUBSEQUENT DRESSINGS.—The *subsequent dressings* are those which are continuously used in the intervals between the cauterizations. Of these the *dry* are infinitely to be preferred to the *wet* dressings. Iodoform is the agent most deserving of praise in this connection, the only objection to its use being the pungent and penetrating odor which it possesses. Many substances have been suggested for the palliation of this defect, the last agent for this purpose being chloral-hydrate, but none of them can claim a great degree of success. Perhaps the best manner of correcting the odor is to instruct the patient not to scatter the powder upon his hands or clothing; if due attention be paid to this point, this disagreeable feature of a valuable drug may be materially modified. Besides the iodoform, the impure oxide of zinc, and powdered tannin, mixed with some inert powder like bismuth or lycopodium, in the proportion of one part of the active agent to three of the inert, is often of service. These dressings should be applied several times during the day, the ulceration being carefully bathed in hot water before each fresh application. After the preparation is dusted on, the part may be protected by the super-position of charpie or of Davison's prepared absorbent cotton, which makes an excellent dressing. Of the *wet* dressings, solutions of carbolic acid are the best, but the objection to their continued use is that they are apt to macerate the epithelium of healthy tissues surrounding the sore, to harden circumjacent parts, and to render the sore indolent and flabby. Another excellent dressing, and perhaps on the whole preferable to carbolic acid, is what is known at Charity Hospital, Blackwell's Island, as the "nitric acid wash," which is simply a fluidrachm of the chemically pure nitric acid dissolved in a pint of water. Should this produce burning and pain in the ulcer for more than three or four minutes after its application, it may be diluted; otherwise it should be kept up to the standard prescribed. Under its use, the surface of the sore loses its grayish look and becomes covered with healthy granulations; the purulent discharge ceases; and the edges of the wound fill up. When this point is reached, the wash may be discontinued, and dry dressing substituted. In the treatment of this

variety of ulcer, special care must be taken to persevere faithfully with the use of the remedies until complete cicatrization has occurred, inasmuch as some chaneroids become freshly inflamed, and break down anew, even when they are apparently on the high road to recovery.

The use of hot-water baths, general and local, has been recommended as another means of treatment for these ulcers, and undoubtedly in those cases which are attended with much inflammation, benefit accrues from this plan. But for the *cure* of chaneroids I cannot speak in the same terms of approbation which some writers employ when speaking of the "hot-water treatment;" the utmost that I have obtained has been relief of inflammation, and this has been notably the case in phagedænic ulcers, in which, after the subsidence of the acute symptoms (the swelling, redness, and pain), the condition of the ulcer has remained stationary, requiring more active measures for its cure; and this, too, although the bath treatment had been diligently and carefully pursued.

TREATMENT OF COMPLICATIONS.

BUBO.—Buboes, according to their stage, require an abortive or a stimulating method of treatment. When first seen, and before any breaking down has occurred, the attempt should be made to cause absorption and disappearance of the swelling. For this purpose, local applications of the tincture of iodine (simple or compound) should be made to the enlarged gland, together with compression, if the condition of the swelling will admit of it. Besides this, applications of nitrate of silver—thirty, forty, or even sixty grains to the fluidounce—and of collodion, either alone or holding iodoform in suspension, have been used with varying success. The internal administration of the sulphide of calcium, in doses varying from one-tenth to one-half a grain, has in my hands not produced satisfactory results, although some writers speak highly of its use in these cases. The application of ice is occasionally of benefit in diminishing pain and reducing inflammation.

As soon, however, as fluctuation is apparent, the remedies mentioned above must be abandoned, and an opposite course of treatment pursued. Everything must now be done to favor suppuration, for the reasons which I have already given, and which will perhaps bear repetition. As already mentioned, when a bubo threatens to break down, it is impossible, until after the bubo has been opened, to declare whether it is of the kind known as "simple," or whether it is "virulent;" hence it is important to favor suppuration, and to settle this point. If the bubo be "*simple*," the mere evacuation of the pus will be almost all the treatment requisite, if we except the dressing of the wound with lint and cold-water bandages. But if the bubo prove to be what is known as the "*virulent* bubo," then the condition of things is materially altered. The ulcer which is left after the evacuation of the pus is to all intents and purposes a chaneroid, and requires active measures for its cure.¹

The first thing to be done is to destroy the inflammatory and destructive character of the ulcer, and this is best done, if the bubo be at all large, by the actual cautery in one of the methods already advised. Any glands which are not yet destroyed should be removed, either with the knife or *écraseur*, and whatever hemorrhage there may be should be checked with the white-hot iron. In making cauterizing applications to these, as well as to other

¹ Aspiration of the bubo in these cases is of no service; a free incision is the best method of treatment.

chancroids, care should be taken to include all portions of diseased tissue. The subsequent dressings should be detergent and stimulating, and the best articles are the nitric and carbolic lotions. These should be applied upon the absorbent cotton, well packed into all portions of the wound until it assumes a perfectly healthy appearance, when they may be discontinued in favor of a dry dressing, usually of iodoform.

PHIMOSIS.—In *phimosis*, the attempt should be made to relieve the swelling and œdema of the prepuce by frequent and continuous, hot, local baths, carried to the point of producing slight faintness. Associated with these, sub-preputial injections of the nitric or carbolic lotions should be made, conjoined with strict attention to cleanliness; as soon as the œdema subsides and retraction of the foreskin is possible, the concealed sore should be treated in the manner already advised. It is better surgery in such cases not to attempt to relieve the phimosis by incision, unless gangrene threatens to supervene, as the cut edges of the wound almost invariably become inoculated, and a large and troublesome sore results. If, however, it becomes necessary to operate, the incision had better be made double instead of single, by making one at each side of the foreskin, instead of the time-honored single cut along the dorsum of the penis. The double incision admits an easier and more thorough exposure of the glans penis and fossa glandis, and a more perfect application of the necessary remedies. The concealed chancroids, as well as the edges of the wounds, should then be cauterized in the manner and with the means already detailed.

PARAPHIMOSIS is usually a less serious accident than the complication we have just been considering, although even here the constriction may be so great as to produce gangrene of the glans penis. If this threatens, it must, of course, be relieved by a timely division of the constricting portion of the prepuce; under other circumstances, the same rule as regards incisions must be observed here as in phimosis. Antiphlogistic treatment by hot-water local baths, leeches to the abdominal rings, multiple punctures of the œdematous prepuce, and the ice-pack, are the remedies which hold out the best and most speedy means of relief; destruction of the chancroids must be always carried out as quickly as possible.

BALANITIS.—In *balanitis* the principal danger arises from the auto-inoculation of the abraded points, and hence these should be cauterized and treated in the same manner as though they were already chancroids.

CONCEALED CHANCROIDS (*Chancres larvés*, of the French), if seated just within the meatus, can generally be treated by cauterization and the dressings already advised, without any great difficulty. If seated further within the canal, the applications must be made through a speculum, for which purpose there is nothing better than a Gruber's ear-speculum. As a matter of fact, I do not believe that these ulcers are ever seated further than one inch within the canal, and the celebrated case of Ricord, described in his "*Clinique Iconographique*," is open to question as regards diagnosis. In many respects it looks as though it had been a case of tuberculosis, and not of chancre.

PHAGEDÆNA.—The most serious of all complications to treat is phagedæna, and the main point to be remembered is, that it is due much more to some constitutional defect than to any local property of the chancre; hence a twofold method must be adopted, namely, local destruction of the ulceration, and an internal treatment to alter the underlying diathesis. The only cautery

which is of any service in these cases is the actual cautery, and this should be thoroughly and mercilessly applied wherever the disease shows itself. The subsequent dressings are best made with the nitric acid lotion, and these should be carefully applied over the entire extent of the sore, the cauterizations to be repeated as long as the floor of the ulcer shows its purulent grayish hue, or the sore exhibits any tendency towards extension. The use of the potassio-tartrate of iron, so much vaunted by Ricord as the "born enemy of phagedæna," does not seem to be as efficacious in this country as abroad, and it has the decided disadvantage of depositing the metallic tartrate of iron over the surface of the sore. Internally, as a tonic, it is sometimes of benefit.

The *internal treatment* of phagedæna must be directed to building up the patient's general health, and, of the various tonics recommended for this purpose—besides the preparations of iron—quinine, cod-liver oil, and phosphoric acid may be used with advantage. Care must be taken not to confound these phagedænic chancreoids of the genitals and of the inguinal region with ulcerating gummata and serpiginous syphilides of the same regions, as those require an entirely different treatment. In chancreoids, mercury and iodide of potassium not only are of no advantage, but often do positive harm, and I believe that many cases of serpiginous chancreoids, which are reported as having been benefited by the "mixed treatment,"¹ are examples of serpiginous syphilides, and not of true phagedænic chancreoids. In the large majority of cases, chancreoids do not need any internal treatment; it is only in those cases in which the patients are debilitated that constitutional remedies are required, and even then tonics, such as iron or quinine, are all that are requisite. In the phagedænic variety of chancreoid, tonics are, of course, a necessity.

MIXED SORE.—As regards the so-called "mixed sore," the treatment is twofold, and must be changed as soon as the character of the local ulceration is altered. As long as the chancreoid exists, the case must be treated as one of chancreoid; but as soon as the ulcer assumes its syphilitic characters, the remedies applicable to the chancreoid must be abandoned, and those remedies adopted which are appropriate for the treatment of the initial lesion of syphilis.

¹ [This name is applied to the combined use of mercury and iodide of potassium.]

VENEREAL DISEASES: SYPHILIS.

BY

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HISTORY OF SYPHILIS.

THE origin of SYPHILIS¹ is involved in obscurity. Whether the disease has everywhere and at all times existed, or whether it has originated at one period or another *de novo*, are questions which, in spite of the vast amount of laborious erudition which has been brought to bear with a view to their solution, cannot at present be regarded as satisfactorily answered.² Our earliest positive knowledge of the disease dates to the year 1495, at which time it appeared, of a malignant type and epidemic in character, in the armies of France, led by Charles VIII. against the kingdom of Naples. The disease not only attacked the invaders but also the defenders of the Italian kingdom, and almost simultaneously overran the whole of Europe.

The earlier writers on syphilis differentiated it with accuracy from the other venereal affections, but later authors confounded the various diseases due to sexual intercourse, until, at the end of the last century, confusion everywhere prevailed.³

The identity of gonorrhœa with syphilis was, however, denied even in the last century by Astruc, Balfour, and Benjamin Bell, but John Hunter, who published his work on venereal in 1786, when at the height of his great reputation, maintained this identity, and taught that the only difference between the two diseases depended upon the nature of the surface to which the poison was applied; that it caused ulceration when it acted upon a cutaneous surface, but only a purulent discharge, without breach of continuity, when applied to a mucous membrane; and that the morbid secretion in either case might give rise to one or the other set of symptoms according to the struc-

¹ As the limits of an article like the present, preclude the full discussion of many points, and necessitate the concise treatment of nearly all subjects included, I have made numerous references through the text to monographs and papers which contain a fuller exposition, or which take different views, of disputed questions. The reader desirous of working out any particular topic will find in the abstracts of current literature published in the Archives of Dermatology, a complete bibliography of syphilis during the past seven years, with an epitome of the more important papers.

² The best recent works on the history of syphilis are, Hirsch (Handbuch der historisch-geographischen Pathologie, 1860-4), and Haeser (Geschichte der epidemischen Krankheiten, zweite Auflage, Jena, 1853 und 1865), in favor of the ancient origin of syphilis, and Geigel (Geschichte, Pathologie und Therapie der Syphilis, Würzburg, 1867) against it. An excellent and full summary is contained in Lancereaux's *Traité historique et pratique de la Syphilis*, 2me éd. Paris, 1874.

³ See Bassereau, *Affections de la Peau symptomatiques de la Syphilis*. Paris, 1852. A book well worthy of the title "epoch making," and one of the most important works ever written upon syphilis.

ture with which it came in contact. With this belief, he inoculated himself on the glans and prepuce with the discharge from a gonorrhœa; the result was the development of primary sores, followed after some months by secondary manifestations from which he was not completely cured for three years. This naturally made a great impression on his mind; he appears to have considered the experiment conclusive, and not to have repeated it upon others.¹

Hunter's great name and the influence of his writings caused the doctrine of the identity of gonorrhœa and syphilis to prevail extensively, and, indeed, it is only within the last score of years that this view has entirely ceased to be held.² The treatment of gonorrhœa by means of the internal employment of mercury, even to salivation, was not uncommon in the first thirty years of this century, and it was not until 1838 that Ricord in his work on the subject³ finally disproved the identity of gonorrhœa and syphilis.

Ricord, while clearly differentiating chancre and gonorrhœa, failed to distinguish accurately the two kinds of sore confounded under the former name, and moreover committed the lamentable mistake of denying the communicability of syphilis by the secretions of its generalized lesions.⁴ His pupils, who founded the modern French school of syphilology, proceeded in Ricord's footsteps and pushed the investigations of the Master still farther, disproving some of his assertions while confirming others.

Bassereau, a pupil of Ricord, first put forward, in 1852, the theory that the two kinds of sore indicated two entirely distinct contagious diseases, having no relation to each other and each invariably only transmitting its like. He arrived at this conclusion by the confrontation of a large number of patients with the individuals from whom they had contracted, or to whom they had communicated, their disease. He found that in every case those affected with chancre followed by secondary infection, had derived their disease from persons similarly affected, with secondary infection. On the other hand, those affected with chancres not causing symptoms of general syphilis, had, without exception, derived their disease from persons who, like themselves, were the subjects of sores whose action was limited to the point first infected.⁵

Ricord had observed that the "indurated" sore could only be inoculated with difficulty upon the individual who bore it, while sores not indurated could be inoculated indefinitely. Moreover, when the indurated sore was inoculated upon its bearer, it gave rise to a sore precisely similar to that caused by inoculation from a non-indurated or "soft" sore. Therefore it was argued by Clerc,⁶ that it was not necessary to imagine, with Bassereau, the existence of two poisons, but that the soft sore was the product of the hard sore when conveyed to a person already syphilitic; that it had permanently lost its infecting property, so that if transmitted further to a person who had never had syphilis, it would still be transmitted as a soft sore without any power of conveying general infection. To this hybrid or degenerated sore, Clerc gave the name of "chaneroid."⁷ Other observers confirmed Clerc's asser-

¹ J. R. Lane, *Lectures on Syphilis*, delivered at the Harveian Society, December, 1876, page 6. 2d ed. London, 1881.

² Bumstead says that it was taught as lately as in 1860, in one of the most prominent medical schools of this country.

³ *Traité des Inoculations appliquées à l'Étude des Maladies Vénériennes*. Paris, 1838.

⁴ Although doubts as to the non-inoculability of "secondary" lesions existed in the minds of various writers previous to Ricord's time, yet his advocacy of this view silenced or convinced his contemporaries, and it was not until the inoculation experiments of Waller, of Prague (*Präger Vierteljahrsschrift*, 1851), and others, that the contagiousness of these lesions was generally acknowledged.

⁵ Lane, *op. cit.*

⁶ *Du Chanéroïde Syphilitique*. *Moniteur des Hôpitaux*, etc. Paris, 1854.

⁷ Laue, *op. cit.*

tions, and it was also found that the "indurated sore," which under ordinary circumstances was inoculated upon the bearer with so much difficulty, could readily be inoculated if it were first irritated by powdered savin or by a seton, and made to produce pus, and that the sore thus arising resembled in every way the soft sore, the "chancre" of Clere.

By this means an unfortunate step backward was taken, and the two poisons which had been so carefully differentiated by Bassereau were once more confounded together, and regarded as essentially one. But these experimenters had proved too much, for others following their lead inoculated simple non-venereal matter of inflammatory origin upon syphilitic subjects, with the result of producing pustules and ulcers identical with the chancre, and capable of reinoculation through a number of generations.

The result of these various observations and speculations regarding the nature of venereal sores has been the gradual evolution of the following theory, which is held by a majority of the most distinguished syphilographers of the present day, and which is accepted by the writer of this article:—

*The virus of venereal sores is of two distinct kinds. Some venereal sores are due to the inoculation of the syphilitic virus, others are due to the inoculation of a distinct specific virus known as chancroidal. These two poisons may be inoculated simultaneously.*¹

GENERAL PATHOLOGY.

Syphilis is a virulent, contagious, inoculable disease, having a sluggish evolution, and manifesting itself, in the acquired form, first by a chancre, then by eruptions on the skin and mucous membranes, subsequently by chronic inflammations of the cellulo-vascular tissues and the bones, and finally by special productions in the form of small tumors or nodules called gummata.²

There are two forms of syphilis, the acquired and the hereditary. Both originate in the same virus, but their course, the lesions by which they are expressed, and the symptoms to which they give rise, are so different that they require a separate description.

Acquired syphilis is the disease communicated by an infected person to one free from syphilis. It first shows itself, precisely at the point of inoculation, by an *initial lesion* or chancre. Hereditary syphilis is the disease derived from one or both parents, either by conception, or through the blood of the mother after conception. In this form of syphilis the initial lesion or chancre is wanting.³

Is chancre the first symptom of a generalized infection, or is it in the beginning merely a local lesion? Observers are not all agreed upon the answer

¹ The other prevailing views represent the virus of chancre either as, according to Clere's view given above, a sort of degenerated syphilitic virus, or as nothing more than purulent infection, and the chancre as in no way distinguishable from the product of the inoculation of pus from simple sores upon persons of peculiar constitution. Among the upholders of the latter view may be mentioned the late Prof. Freeman J. Bumstead, whose opinion justly carries great weight. I cannot, however, admit the identity of the chancroidal virus with that of simple purulent matter, for I believe that the clinical appearance and course of the chancre are so peculiar as to establish its existence as a morbid entity. Two excellent papers by Dr. Bumstead may be referred to in this connection, viz.: "On the present state of the question of the unity or duality of syphilis," *Am. Journ. Med. Sci.*, April, 1873, and "The virus of venereal sores, its unity or duality," *Transactions of the International Medical Congress of Philadelphia*, Phila., 1877. See also a review by Dr. Frederick Zinsser: "The doctrines of unicism and dualism of the syphilitic contagion." *Am. Journ. Syph. and Derm.*, vol. i., 1870, p. 220.

² Cornil, *Leçons sur la Syphilis*. Paris, 1879.

³ Bumstead and Taylor, *The Pathology and Treatment of Venereal Diseases*, 4th ed. Philadelphia, 1879.

to this question, but the weight of evidence, I think, lies in favor of the first view, and against the local character of chancre.

Those who favor the local view of chancre, point to the period of so-called "second incubation," the space of time which elapses after the chancre has appeared, and during which it lies dormant, so to speak, for several weeks before any signs of general infection occur. In opposition to this view, however, it may be remarked, that a period of incubation follows the inoculation of the virus, and that it is during this first "incubation" that the poison is penetrating the system. The chancre is, in fact, the first outward sign of the constitutional infection; the "second incubation" being indeed only a halt between two outbreaks. The fact that auto-inoculation of chancre cannot be effected (see p. 354, note), shows, I think, most conclusively, that the entire system is already saturated with the poison. This question is of practical importance, for if indeed chancre were only a local manifestation, its prompt excision might prevent infection of the system, while if it is only the first symptom of general infection, such treatment must of necessity be useless to prevent the evolution of the disease. The question of excision will be again mentioned under the head of the treatment of chancre.

SOURCES OF SYPHILITIC CONTAGION.—Up to within a comparatively recent period, it was believed that the chancre was the only contagious lesion of syphilis, and the only means whereby the disease could be spread from one individual to another. This theory was strongly supported by Ricord for many years, but this truly scientific syphilographer at last saw his error, and, recanting, uttered in a new edition of his "Letters" the expression of his change of belief.¹ We now know that the generalized lesions of syphilis are among the commonest sources of contagion, and it is no longer the custom, as it was at one time, to charge any individual presenting syphilis, no matter what his or her personal character and antecedents, with having indulged in illicit sexual intercourse. Among the generalized manifestations of syphilis those which are suppurative in character are most apt to convey the contagion. *Mucous papules and patches* are most commonly the source of infection, and after these in point of contagiousness are the pustular syphilodermata—*ecthymatiform, acneiform, and rupial*. The late lesions are not considered contagious, although no direct inoculation-experiments have been practised with these.

The *blood* of persons in the full course of syphilis is certainly infective,² but at a later period its contagious quality gradually declines, and is finally entirely lost.

The contagiousness of the normal secretions of the body—*saliva, sweat, tears, milk, semen*—has been examined into by various experimenters, with negative results, and I think we may say positively, that, as far as our present knowledge goes, none of these secretions act as the carriers of the syphilitic contagion.

MODES OF CONTAGION.—(1) *Immediate*.—The most frequent mode of syphilitic contagion is from the genital organs in sexual congress. Some abrasion of the skin is almost always if not invariably required in order to procure the entry of the virus into the system; this, however, as is known, is not uncom-

¹ "L'homme absurde est celui qui ne change jamais," said Ricord.

² The contagious character of syphilitic blood has been ascertained by direct inoculation upon persons free from syphilitic disease. The fact is now universally admitted, so that it is not necessary to make any direct reference to the original investigations. Important as is the knowledge of this contagiousness of syphilitic blood, the manner in which it was gained, that is, by inoculating in some cases innocent and unsuspecting individuals, was unjustifiable and infamous.

mon in sexual intercourse. Now and then individuals are met with who appear to be quite refractory to the absorption of the syphilitic virus: such persons escape with impunity from an impure connection. Those who suffer from hereditary syphilis are believed to be exempt, and also most if not all persons who have already had the acquired disease. One attack of syphilis usually protects against a second, but this is not invariably the case; Diday¹ and others have reported cases of reinfection, where the disease ran its usual and regular course a second time. This goes to prove that syphilis is a curable disease, a fact which has been denied by some authorities. Now and then cases of contagion by the anus are observed, when this has followed as the result of unnatural intercourse.

Contagion by the mouth is next in frequency to that by way of the genital organs. It is, indeed, not very uncommon. The source of contagion in this case, however, is usually the mucous patch. The most innocent persons may in this way contract the affection by kissing or fondling children suffering from hereditary syphilis, and children may in the same manner contract the disease from nurses, or may give it to them in the act of nursing.²

A few years ago the following case came under my observation, which illustrates the way in which syphilis may obtain entrance to a family quite unawares. A young girl, returning from a ball, kissed on parting the young man who had accompanied her home. She had been suffering from a cracked lower lip, and was consequently not alarmed when a "fever-blister" appeared in the locality a few weeks later. As this did not heal she sought relief after a time at a dispensary, where burnt alum or borax was applied for several weeks longer, the sore growing larger and harder all the time, and "kernels" appearing under the chin. When I saw her, at this time, the girl had a well-marked chancre of the lower lip, with hazel-nut sized induration, and accompanied by enlarged submaxillary glands. On inquiring as to the health of the family I learned that an infant sister, of whom my patient was very fond, had for some little time past showed "fever-blisters" on the commissure of the lips, and on visiting the house I found the child suffering with a small chancre of the commissure, together with a general maculo-papular eruption. I at once quarantined the victims of the disease, but too late, as the mother and two more children subsequently showed generalized syphilitic eruptions, and the family remained under my care and observation for several years, showing various early and late lesions from time to time.

Syphilis is also said, with some indirect evidence of truth, to have been conveyed in the act of ritual circumcision as practised among the Jews, the operator sometimes placing the infant's penis in his mouth, previously filled with an astringent fluid, after the operation, with the view of stopping the hemorrhage.³

Other modes of immediate contagion are the suction of the breast, or a wound, with a therapeutic purpose, the examinations or handlings of a midwife or accoucheur,⁴ or even the pressure of the body, as in cases where nurses have had chancres, the result of carrying infants upon the arm, who were suffering with mucous patches of the anus. Also, one case is recorded where a young man contracted a chancre of the thigh, of which he could give no history, save that he had permitted a ballet girl affected with contagious syphilitic lesions, and probably in very scanty attire, to sit for some time upon his knee. Syphilis is sometimes conveyed by the immediate contagion of bites.

¹ Archives Générales de Médecine, Juillet et Août, 1862.

² See R. W. Taylor, The Dangers of the Transmission of Syphilis between Nursing Children and Nurses, in Infant Asylums and in Private Practice. Am. Jour. Obst., vol. viii. No. 3, Nov. 1875; also, Fournier, Nourrices et Nourrissons Syphilitiques. Paris, 1878.

³ See a paper on the question of the Transmission of Syphilitic Contagion in the Rite of Circumcision, by R. W. Taylor, in the New York Medical Journal, Dec. 1873.

⁴ Bardinet (Mém. de l'Acad. de Méd., Avril 14, 1874) gives the case of a midwife affected with a syphilitic lesion of the finger, through whom more than one hundred persons had been infected.

A case has been reported where a man was bitten in a scuffle by his antagonist, who had mucous patches of the mouth, and where a chancre followed in the wounded locality, and general syphilitic symptoms subsequently developed. I have observed two cases of chancre following bites: in one of these a woman was bitten upon the nipple by her lover, during endearments which were never carried to the extent of sexual connection, and in the other a man was bitten upon the scrotum by a prostitute. In both of these cases I saw the initial lesion at an early date, and followed up the history of the individuals. Similar cases are on record. The operation of skin-grafting may be the means of conveying syphilis.¹

(2) *Mediate contagion* may occur from the passage of a cigar² or pipe from mouth to mouth, from the use of various common utensils,³ from sleeping in the same bed, or from workmen using such tools as are passed from mouth to mouth, as the blowpipes employed in glass works.⁴ Surgical instruments may convey contagion.⁵ Tattooing has sometimes been the means of conveying the poison of syphilis, as in the interesting series of cases, fifteen in all, reported by Maury and Dulles.⁶ Accoucheurs and midwives may become the sources of mediate as well as of immediate contagion. A case has been recorded in which the secretions of the female genitalia were the means of contagion. A woman had connection with a man having an infecting lesion upon the penis, and a few hours after with another man who had never previously had syphilitic disease. The second lover contracted a chancre from this intercourse, while the woman whose vaginal secretions had carried the contagion remained healthy.

In the early history of syphilis, it was imagined that the contagion could be carried by the air as smallpox could, and cases are on record where persons have been accused of conveying syphilis by whispering in the ear. We now know this to be a notion without foundation, and that actual contact is necessary. Another idea which was prevalent to within recent years was, that an infant could contract syphilis from the mother in birth, as it passed through the parturient canal. Why this peculiar theory should have gained currency is hard to say. I believe it is entirely unsupported by any recorded cases.

Many other means of contagion have been recorded by various writers which it is not necessary to enumerate, but the fact should be borne in mind in investigating obscure cases, and the physician should not be too hasty in imputing immorality when outward circumstances are against this view, and when even a possibility of mediate contagion exists. One case may be mentioned. Clerc, a man not likely to take a credulous view of infection, showed to his pupils an old man of seventy, who had not indulged in sexual intercourse for many years. This man presented a chancre of the glans penis, derived from the rubbing of the organ against the front of a pair of suspected pantaloons which he had worn about two months.⁷

VACCINO-SYPHILIS.—The question of the conveyance of syphilis in vaccination is one of great practical importance. The possibility of such an occur-

¹ See Deubel's case. *Gaz. Méd. de Paris*, Nov. 5, 1881, p. 628.

² Two Cases of Chancre of the Lip, probably acquired through Cigars. *Transactions of the American Dermatological Association. Archives of Dermatology*, Oct. 1879.

³ See a Case of Syphilitic Inoculation by a Tooth-brush, by E. B. Baxter. *Lancet*, May 31, 1879.

⁴ Rollet, *Arch. Gén. de Méd.*, 1859; *Gaz. Méd. de Lyon*, Nov. 16 et Déc. 1, 1862. Also Dechaux, *Épidémie syphilitique à la verrerie de Montluçon. Gaz. Méd. de Lyon*, Nos. 15 et 16, 1867.

⁵ As the Eustachian catheter. See Laillier and others, in *Bull. et Mem. de la Soc. Méd. des Hôpît. de Paris*, année 1864, pp. 299, 213, et 1865, pp. 134, 136.

⁶ *Am. Jour. Med. Sci.*, Jan. 1878.

⁷ See also Hyde, On Some Sources of Syphilitic Infection (*American Journal of the Medical Sciences*, January, 1874), and Rohé, Two Cases of Syphilis in which the Infection took place in rather Unusual Situations (*Chicago Medical Journal and Examiner*, July, 1878).

rence was suggested as far back as the beginning of the present century, but general attention was drawn to the subject only as recently as 1852, when a veterinary surgeon of Berlin was condemned to fine and imprisonment for having conveyed syphilis to nineteen individuals by vaccination. The virus was conveyed by an infant, whose health appeared perfectly good up to the day of vaccination, but who, seven days afterwards, broke out with a general erythematous syphiloderm. In 1861 occurred the famous epidemic of Rivalta, a small Italian village of 2000 inhabitants. Two series of vaccinations were performed, with an interval of ten days. Some time after the first, thirty-eight children showed manifest symptoms of syphilis; in the second, one of these thirty-eight transmitted the disease to seven persons. These facts, as well as others subsequently reported, attracted much attention, and the subject has of late years been studied with the result of making the symptoms and course of this form of disease much better known than formerly.

A remarkable fact is, that in many of the reported endemics, the syphilitic manifestations appeared at different times and in different forms in the various infected individuals. Some showed an early occurrence of characteristic cutaneous and mucous eruptions, while in others the disease appeared at a later date, in the form of a lesion limited to the point of inoculation, generalized manifestations not appearing for four or five weeks more. Another confusing circumstance was, that, many cases being inoculated with a liquid from the same source, the operation conveyed to some vaccinia, or syphilis, only, while others showed both affections simultaneously. In certain rare cases the vaccinifer was found to be healthy. Viennois explained these apparently contradictory phenomena by showing that, when syphilis is transmitted by means of vaccination, the first lesion is a chancre at the point of inoculation, appearing after the usual period of incubation, and followed after the customary interval by general symptoms. When, however, the symptoms appear suddenly some days after inoculation, they cannot be regarded as the direct consequence of this procedure. Clinical observation has shown that the modification induced in the organism by vaccination may precipitate the appearance of eruptive symptoms, in cases of individuals under the influence of syphilis.

It remains to determine the agent of the contagion. The liquid of the vaccinal vesico-pustule cannot be held accountable, since, in many of the infants vaccinated in the course of the various "epidemics," no syphilis followed. As we know that the blood of syphilitics is poisonous and infective, it appears likely that this was inoculated in the cases of transmission reported. The history of the cases makes this more sure, since it points to certain series of cases, where those vaccinated first from the arm of a syphilitic vaccinifer remained intact, while those near the end of the list, when the vesico-pustule was scraped by the lancet in order to obtain the last drops of vaccinal fluid, suffered infection. It should be said, however, that all writers are not in accord regarding the theory that the blood alone is the infective agent in these cases. Epidermic scales, leucocytes, and lymph, according to some observers, may also be the vehicles of contagion. It has been asked whether the blood of an individual who has received the double inoculation of vaccinia and syphilis is virulent already at the moment when the vaccinal pustules are developed—that is, about the seventh day—and consequently before the appearance of the chancre. The fact is as yet doubtful, although the following case seems to favor the affirmative: During the epidemic of Rivalta, a certain patient, who had served to vaccinate, on the 12th of June, seventeen infants, of whom seven were subsequently affected with syphilis, observed her vaccine pustules changing to indurated ulcers. On the 2d of August, the patient's skin became covered with an erythematous syphiloderm.

To sum up: Vaccino-syphilis may be derived from two sources, the vac-

cinifer and the vaccinated. The contagion is carried by means of the blood, and possibly by the epithelial scales and the white globules, and may infect either the vaccinifer or the vaccinated.¹

Fournier says that to distinguish between vaccinal syphilis (that when infection and vaccination are simultaneous) and the syphilis which is post-vaccinal (that declared in a congenitally diseased infant after vaccinia), it should be remembered:—

(1) That in vaccinal syphilis there is a chancre at the point of inoculation with characteristic adenopathy of vicinity, while in infantile syphilis there is no chancre, but cutaneous, glandular, visceral, osseous, and other lesions.

(2) The evolution of vaccinal syphilis is accomplished in the four periods of (a) twenty-day incubation, (b) explosive chancre, (c) forty-five-day incubation, (d) explosion of generalized symptoms.²

GENERAL SYPHILIS ALWAYS FOLLOWS A CHANCRE.—Experience and also the results of accurate statistical inquiry show that in the vast majority of cases of secondary syphilis, the existence of a previous chancre can be proved. Bumstead and Taylor give collated statistics of 1291 cases, in all of which, with the exception of 22, general syphilis was preceded by a chancre. These statistics, together with the fact that chancres are capable of spontaneous cicatrization, and may entirely disappear without leaving a trace, and also that in some situations, as the interior of the urethra, vagina, cervix uteri, and the buccal and rectal cavities, they may escape notice or be almost impossible to detect, render it extremely probable (indeed, it may be said certain) that general syphilis invariably originates in a chancre. It should be added that very many persons have had chancre without being aware of the fact, and that chancres are sometimes detected upon the persons of patients who are quite ignorant of their character and even of their presence. The chancre is often the most insignificant of all lesions.

The initial lesion of syphilis is always a chancre, whether the infection has been derived from a chancre in the giver or from a secondary lesion.

Syphilis has a certain definite period of incubation between the appearance of the chancre and the outbreak of the generalized lesions, which varies according to Diday's statistics³ between 25 and 105 days, the average (of 52 cases) being 45 days.⁴

Bumstead and Taylor (op. cit.) sum up the matter in the following propositions:—

A venereal ulcer which is not subjected to specific treatment (so called) will usually, if at all, be followed by secondary symptoms within fifty days, and always within six months.

Conversely: The earliest symptoms of general syphilis (except in cases of hereditary origin) have been preceded by a chancre, probably within fifty days and certainly within six months.

¹ Jullien, *Traité pratique des Maladies Vénériennes*. Paris, 1879.

² A series of excellent papers by Dr. Frank P. Foster, of New York (*Am. Jour. Syph. and Derm.* vol. i., 1870, pp. 189, 293; vol. ii., 1871, p. 38; vol. iii., 1872, pp. 152, 318; vol. iv., 1873, p. 201), gives a complete review of the subject of vaccinal syphilis. See also a review by Dr. M. H. Murray, in the same *Journal*, vol. iv., 1873, p. 112, and see also Hutchinson, *Illustrations of Clinical Surgery*, Fasc. vi.

³ Diday, *Nouvelles Doctrines sur la Syphilis*, p. 265.

⁴ Excluding one case in Diday's statistics where the inoculation was 105 days, the next highest figure is 70 days, and the average would then be much less. Bumstead and Taylor in giving these statistics remark that in 38 of the 52 cases, or in about four-fifths, this period was from 35 to 50 days.

Fournier¹ gives the following striking analysis of the "drama" of the apparition and development of syphilis.

FIRST ACT: *Contamination.* The virus penetrates the organism by one mode or another.

FIRST INTERVAL: *Apparent repose of the organism—incubation.* Nothing appreciable betrays the disease as yet.

SECOND ACT: *Production at the point where the virus has penetrated, and only here, of a lesion called initial, which for the time constitutes the only expression of the disease.*

SECOND INTERVAL: *Another period of repose of the organism.* The initial lesion continues to be the only symptom by which the disease is expressed.

THIRD ACT: *Explosion of multiple and disseminated lesions, beyond and outside of the seat of contamination.* This is the period of visible generalization of the disease.

SYPHILIZATION.—Between the years 1844 and 1850, Dr. Auzias Turenne, of Paris, brought forward and urged a theory of the prevention and cure of syphilis by means of "syphilization," asserting that repeated and successive inoculations of the syphilitic virus would produce in animals and men a syphilitic saturation, and, as a result of this, certain immunity from a second infection of the same virus. Following him, Sperino, of Turin, as a result of numerous experiments, maintained that repeated and successive inoculations of the syphilitic virus, carried to saturation, would procure not only immunity against the infection of this same virus, but would also serve to cure the various syphilitic manifestations, initial as well as generalized. At the time this theory was brought forward, no clear distinction was made between the virus of chancreoid and that of syphilis. We now know that, while the chancreoid is auto-inoculable, the unirritated chancre is not at all, or rather only very rarely, inoculable on the individual bearing it. Auzias Turenne, and those who shared his belief, usually inoculated the chancreoid, and, finding that after repeated inoculations the sore could no longer be reproduced, concluded that the individual was saturated with syphilis and incapable of infection. He proposed syphilization as a prophylactic measure to be employed upon the community at large, and his earnest, impassioned, and persistent advocacy of his peculiar views gained for them an amount of attention which, in the present state of our knowledge, it is difficult to understand. At present we know that the inoculation with venereal virus can have but two results, either (1) the individual experimented upon is already syphilitic, in which case the inoculation, if made with syphilitic virus, will be without effect—inoculations made with chancreoid virus, however, being capable of indefinite repetition; or (2) the individual is free from syphilis, when the first inoculation of syphilitic virus will give him the disease; he will be in the same category as the former individual; and further inoculations will be without effect, while, as before, chancreoid virus may be reinoculated indefinitely.

Boeck, of Christiania, was the most illustrious disciple of Auzias Turenne, and worked for years at the subject, finally compassing sea and land to make converts to his views, which were everywhere received with attention, fully investigated, and—rejected. Put to the test of careful observation by disinterested investigators, the theory of syphilization was found to have absolutely no foundation in fact, and with the death of its enthusiastic advocates, Auzias Turenne and Boeck, the theory also died out completely.²

¹ *Leçons sur la Syphilis.* Paris, 1873.

² For a fuller exposition of the theory of syphilization, the curious reader may refer to Bunsen's work (3d edition), and to Report of Cases treated at Charity Hospital (*Am. Jour. Med. Sci.*, July, 1870). Also to the original papers and works of Auzias Turenne (*De la Syphilisation ou Vaccination Syphilitique.* *Arch. Gén. de Méd.*, 1851, 4e sér. t. xxvi.); Sperino (*La Syphilisa-*

SYPHILIS IN ANIMALS.—Although the chancreoid virus has been successfully inoculated upon animals, yet syphilis has never yet been produced in any of the brute creation, though very numerous efforts have been made to attain success in such inoculations, and though a variety of animals have been made the subjects of experiment. Thus, inoculations have been practised upon the monkey, dog, cat, horse, mule, sheep, rabbit, rat, Guinea-pig, and heifer, but invariably without result.¹ There is, however, room for further investigation in this direction.

REINFECTION IN SYPHILIS.—Syphilis commonly occurs but once in the same person. The immunity conferred by one attack is just as great as in the case of the various other contagious and constitutional diseases—smallpox, scarlet fever, etc. Most of the numerous cases of syphilitic reinfection reported have been cases where lesions have relapsed after a certain interval, or where the observations were so imperfect as to throw much doubt upon their accuracy. In most instances a recent attack of syphilis may be recognized—(1) By the induration of the preceding chancre and neighboring lymphatic ganglia. (2) By the time elapsing between the appearance of the suspicious ulcer and that of the general symptoms, the interval, when the latter are dependent upon the same infection as the former, and in the absence of treatment, being very uniformly about six weeks, and rarely exceeding three months. (3) By the character of the lesions, whether belonging to an early or late stage of syphilis. In the absence of these signs we may ascribe the lesions to an old infection. Before we can admit a second attack of syphilis, we must have an undisputed history of the first infection; we must have proof beyond doubt of a second chancre, which is followed by *well-marked enlargement of the inguinal ganglia*, and at a later period by *secondary manifestations of an undoubtedly syphilitic nature*. Without this succession of lesions similar to those of the first attack, we cannot admit the claims of any case of syphilitic reinfection.² A very considerable proportion of the reported cases of so-called syphilitic reinfection are nothing more than relapsing lesions of the original attack.³

THE EVOLUTION OF SYPHILIS.—Writers upon syphilis usually classify the manifestations of the disease under the heads "Primary," "Secondary," and "Tertiary." This is, however, as regards the last two divisions, an arbitrary distribution, and one not always according to nature. For the "tertiary" lesions do not invariably appear in their due time, but may show themselves in the "secondary" period, without regard to preconceived ideas of their proper sequence, and without following the precedence commonly assigned to them. For this reason I prefer to classify the various stages in the evolution of syphilis as follows: (1) Period of the initial lesion or chancre; (2) Period of generalized lesions. These latter I shall consider according to their anatomical seat, and not generally according to their received chronological development. Hereditary syphilis, as *sui generis*, must be considered separately.

The evolution of the various lesions commonly occupies about the same

tion étudiée comme méthode curative et comme moyen prophylactique des Maladies Vénériennes. Paris, 1853); and Boeck (Syphilisationen Studeret ved Sygesengen. Christiania, 1854; and On Syphilization, Am. Jour. Syph. and Derm., vol. i., 1870, p. 1).

¹ See Traité théorique et pratique de la Syphilis et des Maladies Vénériennes, p. 85. Par MM. les Docteurs L. Belhomme et Aimé Martin. 2me ed. Paris, 1876; and Jullien, op. cit., p. 547.

² Bumstead and Taylor, op. cit., p. 421.

³ See Kobner, Reinfection in Constitutional Syphilis. (Berlin. klin. Wochens., Nov. 1872. Translated in Am. Jour. Syph. and Derm., vol. iv., 1873, p. 128.)

chronological period, but this may be modified by the constitution and age of the patient, and still more by treatment.

The following Table gives approximately the date of development of the various lesions following the appearance of the chancre. It may be of service in giving a general idea of the duration of the disease in any given case, but cannot be depended upon invariably, because, as has been remarked, treatment and other circumstances may modify the evolution of syphilis to a considerable degree. It has been compiled from various sources by Martin,¹ and is here quoted from Bumstead and Taylor :—

Symptoms.	Date of usual development.	Date of earliest development.	Date of latest development.
The erythematous syphiloderm	45th day	25th day	12th month
Papular syphiloderm	65th "	28th "	12th "
Mucous patches	70th "	30th "	18th "
Secondary affections of the fauces	70th "	50th "	18th "
Vesicular syphiloderm	90th "	55th "	6th "
Pustular "	80th "	45th "	4 years
Pustulo-bullous syphiloderm ("Rupia")	2 years	7th month	4 "
Iritis	6th month	60th day	13th month
Syphilitic sarcocele	12th "	6th month	34th "
Periostitis	6th "	4th "	2 years
Tubercular syphiloderm	3-5 years	3 years	20 "
Gummy tumors	4-6 "	4 "	15 "
Onychia	4-6 "	3 "	22 "
True exostosis	4-6 "	72 "	20 "
Osteitis, changes in the bones and cartilages	3-4 "	2 "	41 "
Perforation and destruction of the velum palati	3-4 "	2 "	20 "

CHANCRE.

The chancre is the first local manifestation of syphilis. It appears at the point where the syphilitic virus has been inoculated, showing itself after an average incubation of from about twenty to thirty days.

Although twenty-one days is given as the average period of incubation of the chancre, it must be remembered that in practice quite a considerable variation from this figure in both directions is encountered. Perhaps it would be safe to allow from fifteen to thirty-five days as the ordinary limit of variation. The following table² gives the result of a large number of observations by different syphilographers :—

¹ De l'Accident primitif de la Syphilis constitutionnelle, p. 87. Paris, 1863.

² Jullien, op. cit., p. 552.

Duration of incubation.	Diday.	Le Fort.	Mauriac.
1 day	1 case	0 case	1 to 10 days 0 cases.
3 days	0 "	3 cases	
4 "	0 "	2 "	
5 "	1 "	2 "	
6 "	0 "	6 "	
7 "	0 "	3 "	
8 "	2 cases	49 "	
9 "	1 case	11 "	
10 "	2 cases	35 "	
11 "	2 "	2 "	10 to 20 days 3 cases.
12 "	5 "	17 "	
13 "	0 case	5 "	
14 "	0 "	5 "	
15 "	4 cases	114 "	
16 "	1 case	5 "	
17 "	0 "	4 "	
18 "	2 cases	5 "	
19 "	0 case	2 "	
20 "	1 "	13 "	20 to 30 days 5 cases.
21 "	2 cases	20 "	
22 "	1 case	8 "	
23 "	1 "	7 "	
24 "	1 "	10 "	
25 "	0 "	9 "	
26 to 30 days	1 "	56 "	
5 weeks	0 "	10 "	
6 "	0 "	20 "	
7 "	0 "	3 "	30 to 40 days 14 cases. 40 to 50 days 15 " 50 to 60 days 5 " 60 and above 8 "
2 months	0 "	10 "	
3 "	0 "	2 "	
	28 cases	438 cases	50 cases.

The typical chancre, as seen on the genitals, begins as a faint erythematous point, which rapidly develops into a pin-head sized papule, slightly eroded on its surface, and usually looking like a mere abrasion. As a lesion it is trifling. As Fournier remarks, it is "the smallest, the most superficial, the most benign, the most insignificant of all possible erosions." This abrasion or erosion is roundish, oval, or sometimes linear, and covered, excepting at its border, with a grayish pellicle (Plate XVIII. Fig. 1). It suppurates very slightly; is, indeed, scarcely more than slightly moist on the surface. In some cases it grows no larger; in other instances it increases in size progressively until it may attain the diameter of a centimetre or more, its base meanwhile becoming firmer and larger—indurating, in fact, until it has reached maturity (Plate XVIII. Fig. 2).

In some cases the chancre first shows itself as a large papule, but after a time the surface of the lesion becomes excoriated or slightly ulcerated, and follows the same course as the typical lesion just mentioned. The floor of the chancre is very slightly eroded, the edges sloping gradually, not clear cut and excavated as in the case of chancreoid. Now and then, however, venereal sores are met with where considerable inflammation and suppuration have occurred, and where the edges of the sore are more or less excavated. In these cases it is impossible to distinguish the nature of the lesion at first, and the diagnosis for the time must be held in suspense. If the sore is a chancre, the characteristic induration of its base supervenes.

INDURATION OF CHANCRE.—This induration is an important element in the characteristic picture of chancre. It usually shows itself in the first week of the sore. Sometimes, however, it is delayed for two or three weeks. It is



Various Forms of Chancre.



slight at first, but gradually increases in amount up to the time when the chancre heals over, when it begins to decrease again and gradually disappears, usually within a few weeks, but sometimes not for months. The induration underlies and surrounds the sore, which lies in it as if in a cup. When the sore is large and ulcerated the induration may be comparatively slight—so slight as to be called “parchment induration.” In other cases the induration is very considerable, raising the sore decidedly above the level of the surrounding skin. This is the *ulcus elevatum*¹ of certain writers (Plate XVIII. Fig. 3).

Induration is more marked in some localities than in others; thus, in chancres of the preputial mucous membrane, the corona glandis, and the balano-preputial groove, induration is apt to be more decided than in chancres of the skin. In women induration rarely occurs to a marked degree. It is, however, rarely absent in any case, and forms one of the most distinctive characteristics of the chancre. Now and then a small abscess forms in the induration just as it begins to be absorbed. Occasionally the induration ulcerates, so that it sometimes looks as if a new chancre were forming on the seat of the old one.

VARIOUS FORMS OF CHANCRE.—Fournier² gives an excellent description of the various clinical aspects presented by chancre as ordinarily met with. He gives the four following types: 1. The *erosive*, desquamative chancre; 2. The *exulcerative* chancre; 3. The *ulcerative* chancre; 4. The *papular* chancre. The *erosive* chancre consists simply of an epidermic or epithelial desquamation, which merely denudes the derma without excavating it. The *exulcerative* chancre attacks the derma superficially, laying it bare but not actually excavating it. The *ulcerative* chancre, on the other hand, is hollow, excavated, jagged—an ulcer in fact, but an ulcer at the expense of its own tissues. Finally, the *papular* or elevated chancre is situated on a sort of raised plateau, and forms a disk rising above and sharply defined from the surrounding tissues; it sometimes assumes the appearance of the *ulcus elevatum* mentioned above.

A further variety of chancre is worthy of mention; it is that known as the “*multiple herpeticiform*” chancre, where half a dozen or a dozen lesions appear simultaneously. Care must be taken not to confound these lesions with those of simple herpes progenitalis, which they sometimes closely resemble.

“Mixed chancre” is the name given to the sore resulting from the inoculation of the syphilitic and the chancreoid virus at the same point. A person having a chancre may have connection with another individual free from syphilis, but having a chancreoid, and may contract a chancreoid on the very syphilitic sore, the two diseases running their course side by side. Or a person having a chancreoid may have the sore inoculated with syphilis. The “mixed chancre” is not an entity; it cannot be transmitted from generation to generation as such.

CHANCRE USUALLY SOLITARY.—The chancre is usually solitary,³ the reason being that the virus is not auto-inoculable. To have more than one chancre

[¹ This term is also applied by some writers to the chancreoid. Vide *supra*, p. 318.]

² Op. cit., and also in *Annales de Dermatologie et de Syphiligraphie*, n. s., t. i. p. 750, from *Jour. de Méd. et Chir. Pratiques*, 1880.

³ Fournier (op. cit., p. 75) gives the following statistics, relating, however, to women only: Of 203 patients observed, 134 had a single chancre; 52 had two; 9 had three; 4 had four; 3 had five; and 1 had six chancres. He also gives, as extraordinary, one case where nineteen and another where twenty-three chancres occurred simultaneously.

we must have simultaneous inoculations at various points.¹ The solitary character of chancre is important from a diagnostic point of view.

CHANCRE INVOLVES THE NEIGHBORING LYMPHATIC GLANDS.—The chancre almost invariably² gives rise to involvement of the neighboring lymphatic glands, the glands affected being multiple, separate, so that they can be rolled under the finger, hard, indolent, without change of color, and, unlike the lymphatic engorgement of chancreoid, only very rarely suppurating. The lymphatic engorgement of chancre is gradually absorbed, and disappears in a variable length of time.

It often happens, when the duration of the chancre is prolonged beyond the ordinary limit, perhaps to three or four weeks, that the “constitutional” or generalized symptoms manifest themselves concomitantly.

CHANCRE RARELY COMPLICATED BY INFLAMMATION OR PHAGEDÆNA.—The chancre is very rarely complicated by phagedæna or gangrene, and seldom even shows inflammatory symptoms. After remaining for some days stationary at its period of full development, it tends to heal over, and is generally completely cicatrized at the end of a month.

CHANCRE MAY BE TRANSFORMED INTO A MUCOUS PATCH.—When the chancre takes on the form called *ulcus elevatum*, it often closely resembles the mucous papule, and may easily be mistaken for this lesion; indeed, when the general eruption takes place before the chancre is completely cicatrized, the latter is occasionally transformed into a mucous patch.³

RELATIVE FREQUENCY OF CHANCRE OF DIFFERENT LOCALITIES.—Chancre has no exclusive place of election: it occurs wherever the syphilitic virus has been deposited on an absorbing surface. Of course the genitalia are by far the most frequent seat of the lesion, being affected in about the proportion of 95 of every 100 instances.

The relative frequency of chancre in the various genital regions is shown in the following tables.

SEAT OF GENITAL CHANCRES IN THE MALE.

(Clerc's figures.)		(Fournier's figures.)	
Total number	394	Total number	445
Internal surface of the prepuce	63	Glans and prepuce	314
Balano-preputial fold	171	Preputial furrow	60
Orifice of the prepuce	35	Multiple, that is showing chancres of the furrow and prepuce, or of the furrow and glans	11
Frænum	14	Meatus urinarius	32
Glans	12	Intra-urethral	17
Meatus nrinarius	33	Scrotum	7
Cutaneous surface of penis or prepuce	58	Peno-scrotal angle	4
Scrotum	3		
Peno-scrotal angle	5		

¹ Fournier inoculated the discharge of ninety-nine chancres upon the patients themselves and succeeded in but one instance, in which the experiment was performed within a very short period after infection. Puche states as the result of his experience that auto-inoculation of the chancre is successful in only two per cent. of cases. Poisson obtained like results in fifty-two cases, and Laroyenne was unsuccessful in every one of nineteen. (Bumstead and Taylor, *Pathology and Treatment of Venereal Diseases*, 4th ed., p. 436.)

² So invariably that the glandular involvement is a better sign of chancre than even induration.

³ See Fournier, *Des Indurations secondaires et des Transformations du Chancre*. *Annales de Dermatologie et de Syphiligraphie*, t. iii. p. 255.

SEAT OF GENITAL CHANCRES IN THE FEMALE.

(Fournier.)

Total number	249
Labia majora	114
Labia minora	55
Fourchette	38
Neck of the uterus	13
Clitoridian region	10
Vulvo-vaginal orifice	9
Meatus urinarius, or urethra	7
Superior commissure of vulva	2
Vagina, properly so called	1

GENITAL CHANCRES.

Among genital chancres, those of the *urethra* in the male and of the *cervix uteri* and *vagina* in the female deserve especial notice.

CHANCRES OF THE URETHRA.—Chancres of the *meatus* are not by any means as rare as those of the deeper portion of the urethra. Jullien,¹ in a total of 1773 chancres collected by himself, reports 89 chancres of the meatus and but 17 of the deep urethra. Bumstead and Taylor² have seen several examples, one, two, and even three inches from the orifice. Keyes³ has observed two, one of which was one and a quarter inches from the meatus. Hyde⁴ has also observed two cases. When the meatus is involved, the chancre, incessantly irritated by the urinary current, sometimes presents the irregular appearance of chancreoid; it is irritable, and is said to possess a tendency to phagedæna. The deformity frequently occasioned is characteristic, the induration (late sometimes in its appearance) causing the glans to look as if carved out of wood. A peculiar, square, somewhat enlarged urethral orifice is the occasional result of chancre in this situation. To perceive the induration of chancre of the meatus or *deep urethra*, the penis should be grasped between the thumb and forefinger in an antero-posterior direction. The attention is usually first attracted by a slight impediment to urination, and a purulent discharge, due to a surrounding urethritis set up by irritation in the mucous membrane of the neighborhood, the case resembling one of anomalous gonorrhœa.⁵ With the endoscope, chancre of the deep urethra can be seen as an erosion of the urethral walls, which have a grayish-red color.

Chancre of the urethra is not usually painful. A characteristic sign, which is mentioned by Bumstead and Taylor, consists in inflammatory thickening of the prepuce on either side of the frænum. The symptom is so constant as to be of considerable diagnostic value. Other aids to the diagnosis between chancre of the urethra and gonorrhœa are the slight, gluey, perhaps bloody, discharge, the localized impediment to urination, the subacute course of the lesion, and the involvement of the inguinal glands.

Chancre of the urethra, especially when deeply situated, sometimes results in stricture to a greater or less degree, which must be divided with a knife.

¹ Op. cit., p. 582.² Op. cit., p. 571.³ The Venereal Diseases. New York, 1880, p. 89.⁴ Chancre of the Meatus and Urethra in the Male. Chicago Med. Jour. and Exam., Aug. 1880.⁵ The occurrence of chancre of the urethra has been thought the cause of Hunter's mistake in taking gonorrhœa to be a syphilitic manifestation. John Hunter inoculated himself with the matter from a gonorrhœa, the result of which was the development of primary sores followed by general infection of the system. Ricord believed that Hunter had accidentally inoculated himself from a urethral chancre, but Lane (op. cit., p. 6) suggests the greater probability of conveyance of the syphilitic poison by the blood or morbid secretions of the person from whom the gonorrhœal matter had been taken.

At times local medication must be used in addition to general treatment. Bunstead and Taylor recommend the use of bougies made of mercurial ointment two parts, and white wax six parts. Occasionally iodoform, one drachm to each ounce of the other ingredients, may be employed.

CHANCRE OF CERVIX UTERI.—Chancre of the *cervix uteri* was formerly regarded as an extremely rare lesion. Fournier, however, met with 13 cases in a total of 249 chancres of the female genitalia, and quite a number of cases have been reported by other observers. It is undoubtedly more common than statistics would seem to indicate, and must often pass unnoticed.

In the majority of cases, this form of chancre occupies the central portion of the cervix, seeming to lose itself in the orifice. It is commonly single, but may be multiple, and varies in size from that of a bean to that of a small coin, sometimes even reaching a diameter of three centimetres. When it occurs of small size it probably often escapes observation. As chancre of the cervix uteri is continually bathed by the various secretions of the locality, its color is less bright than that of the lesion as found on the skin, the surface often being whitish, gray, grayish-yellow, or greenish. Sometimes it is cup-shaped and excavated, particularly when eccentric, with smooth and varnished bottom and borders sharply defined by a purplish or grayish, rose-colored collarette. (See Plate XVIII. Fig. 5.) At other times it is less sharply circumscribed, and its surface is prominent, mammillated, and vegetating, or at times pultaceous. The secretion from chancre of the cervix uteri is commonly scanty or absent.

Induration, although undoubtedly present in these cases, is usually difficult to make out by palpation. In the case of a woman suffering from prolapse of the uterus, on whose cervix a chancre was found, Ricord was able to perceive, on palpation, a sub-chancrous mass of almost wooden hardness, easily defined from the tissues of the surrounding organ.

Chancre of the cervix uteri is *indolent* and *painless*. It does not indicate its presence by any subjective symptom whatever, and is, therefore, as a general thing, only discovered by accident.

Ganglionic involvement is in some cases difficult to recognize, while in others it is due, when present, to the coexistence of other sores than those on the cervix, a circumstance peculiarly liable to occur. In thirty-four cases of chancre of the cervix uteri observed by Fournier,¹ only fifteen were single. In the nineteen remaining cases other ulcers could be seen, thirteen times on the labia, three times on the fourchette, once on the meatus, and twice on the integument about the anus. This circumstance of the multiplicity of lesions may perhaps be explained by the common observation that herpes of the genitals is an almost constant accompaniment of chancre of the cervix uteri.

The *diagnosis* of chancre of the cervix uteri can often be made only after careful examination. It is most likely to be mistaken for *chaneroid* of the same locality, but the latter lesion usually shows more excavation and more decided loss of substance, with undermined and eroded edges surrounded by a reactive inflammatory area. The surface of the chancre, on the other hand, is usually flat and sometimes elevated, without a very sharply defined border. The floor of the chaneroid is rough, uneven, eroded, and covered with a yellowish secretion, while that of the chancre is smooth, as if varnished, grayish, or flesh-colored, and exuding a scanty sero-purulent or sanguinolent discharge. The floor of the chaneroid is soft, that of the chancre hard.

¹ Verbal communication to M. Jullien of later date than the statistics given before. See Jullien, op. cit., p. 588.

DIFFERENTIAL DIAGNOSIS BETWEEN CHANCER AND CHANCROID OF THE CERVIX UTERI.

(Fournier, op. cit., p. 300.)

	CHANCER OF THE CERVIX.	CHANCROID OF THE CERVIX.
Signs of a probable character.	I. Habitually single on the cervix. Rarely multiple.	I. Single or multiple (often single from the fusion of several neighboring sores).
	II. Commonly of limited extent.	II. Often extensive.
	III. Always erosive, or papulo-erosive.	III. Sometimes ulcerative with irregular jagged edges; sometimes also papular, but with irregularities of surface depressions and elevations.
	IV. Of an opaline tint, grayish and pseudomembranous.	IV. Yellow or yellowish in color, and of a brighter tint than the grayish dusky shade of the chancre.
V.	Coincidentally, at the vulva, either absence of any lesion, or chancres. ¹	V. Coincidentally, at the vulva, chancroids of unmistakable character, and more or less numerous. In some cases chancroids in the vaginal ampulla in the neighborhood of the cervix.
VI.	Auto-inoculation negative.	VI. Auto-inoculation producing a chancreoid.

Chancres of the cervix must sometimes be differentiated from *follicular ulcers*. These are small, cup-shaped, situated in the follicles, and usually no larger than the follicle from which they are derived. Catarrh of the cervix, hypertrophy of the cervix, fluor albus, etc., are also accompaniments of follicular ulceration of this region. *Simple erosions* sometimes resemble chancre, but only in the earliest stage of the latter. *Papillary erosion*, a metamorphosis of simple erosion characterized by the dark red points of papillæ denuded of their epithelium, which are scattered over the surface and accompanied by cervical and vaginal catarrh, must also be differentiated. The so-called *herpetic ulcer* may sometimes resemble chancre, but it is apt to be multiple, and the lesions run together forming an irregularly outlined sore. In addition, little herpetic ulcers tend to rapid cure. *Carcinoma* is distinguished from chancre of the cervix uteri by its crater-like excavation, the depth of the sore, with irregular, thick, hard, bosselated edges; the uneven floor, covered with a dirty, purulent, and ill-smelling secretion; the frequently accompanying hypertrophy of the cervix, with immobility of the uterus itself as the growth progresses; the occasional stubborn bleeding; the pain; and finally the age of the patient. *Tuberculous* ulcers of the cervix are almost unknown as primary appearances, and are accompanied by signs of tuberculosis in other organs.²

CHANCRES OF THE VAGINA.—Chancre of the vagina (excepting in that portion immediately within the vulvar ring), is excessively rare. Among 249 chancres of the female genital organs, Fournier saw only one in the vagina, and that doubtful. Binet,³ in 128 chancres of the female genitalia, only observed two cases. The vaginal mucous membrane with its thick layers of epithelium is seldom eroded in sexual intercourse, and this will account for

¹ A reservation must be made in the possible but exceptional circumstance of double contagion.

² See an excellent article on the diagnosis of chancres of the cervix, by Rasmussen (Vierteljahrsschr. für Dermatologie und Syphilis, Bd. viii. S. 517), of which an abstract may be found in the Philadelphia Medical Times, March 26, 1881.

³ La France Médicale, t. i. p. 38; abstract in Archives of Dermatology, July, 1881, p. 334.

the rarity of the vaginal chancre. Binet describes the lesion in one case as situated on the right vaginal wall, near the inferior extremity of the os uteri; a centimetre in diameter; the floor red, smooth, shining, and non-purulent; the edges slightly elevated and passing without a ridge into the bottom of the erosion. Induration was difficult to make out from the peculiar situation of the chancre, but by passing the finger lightly over the tissues in the neighborhood, a slight resistance could be perceived as of a more resilient surface. The lymphatics running along the walls of the vagina were enlarged, and appeared to leave the erosion and run toward the indurated post-pubic ganglia. Small ganglia could also be perceived in the neighborhood of the obturator foramen. In Binet's other case, the chancre was situated on the posterior wall of the vagina just within the carunculæ myrtiliformes. It was about two centimetres in diameter, and presented the same features as the lesion in the first case.

EXTRA-GENITAL CHANCRES.

Extra-genital chancres occur in men in the proportion of 6 per cent. of chancres of all kinds. In women, the proportion of extra-genital chancres is much greater, amounting to 16 per cent., an important clinical fact. The usual seat of extra-genital chancre is about the mouth in both sexes, and, in women, about the anus and on the breasts. The chancres of other extra-genital localities are much less frequent.

The following statistics,¹ compiled from various sources, show the comparative frequency of the different extra-genital chancres in men and in women.

Men.		Women.	
Anus	12	Anus and perineal region	21
Lips	36	Lips	20
Gums	1	Tongue	2
Tongue	8	Uvula	2
Nose and cheek	3	Mouth (in general)	4
Eyelids	2	Breasts	11
Abdomen	9	Groin and thigh	8
Buttock	1	Buttocks	4
Lower limbs	3	Ala nasi	6
Fingers	2	Forehead	3
	77	Neck	1
			82

BUCCAL CHANCRES.—Among chancres of the *buccal region* those of the *lips* are the most common. Chancre of the lip may be a very minute and insignificant lesion. It may also be a more extensive ulcer, raised, crusted, and involving the skin beyond the muco-cutaneous surface of the lip, being accompanied by very considerable œdematous swelling and firm infiltration of a characteristic sort, usually insensitive, but sometimes giving pain from tension, and not infrequently causing so much eversion of the lip as to prevent the mouth from being closed (Plate XVIII. Fig. 4). Chancre of the lip may also be a fissured ulceration, springing from a cracked lip, and unfortunately too apt to be mistaken for this trifling lesion. When chancre occurs on the inner surface of the lip, the ulcer is less elevated than in chancre of the outer aspect, and is occasionally accompanied by perceptible loss of substance. The submaxillary glands become swollen in about ten days after the appearance of the chancre, and often give rise to much pain and discomfort. In infants, buccal chancres are usually derived from mucous patches on the nurse's nipple.

¹ Jullien, op. cit., p. 533.

Chancres are also met with on the *gums*, the *gingivo-labial surface of the tongue*, the *velum palati*, the *tonsils*, and the *pharynx*, the sore in each locality presenting certain characteristic features. Chancre of the *tongue* is usually situated on the top of this organ, and presents a peculiar opaline surface, which may cause it to be mistaken for a mucous patch. Chancre of the tongue may become phagedænic and be transformed into a large ulcer. One such case has been cited by Jullien. Chancre of the *tonsil* is very rare, and its existence even has been disputed. The lesions, as described, are never sharply defined. They are dark-red, superficially ulcerated nodules, which secrete a scanty fluid. The history of the case, the subacute course of the nodules, the absence of inflammatory symptoms, and the enlargement of the cervical and submaxillary ganglia, would be the points upon which to rely in arriving at a diagnosis. Phagedæna is a rare complication of the buccal chancre wherever found.

ANAL AND RECTAL CHANCRE.—Chancre of the *anus* is much commoner among women than among men. In the former, it is probably, as a general thing, communicated by accidental contact in normal sexual intercourse, while in men the existence of chancre of the anus gives just cause for suspicion of unnatural abuse, though it is possible that it may be contracted by contact with the finger, etc. French statistics show that in men 1 chancre in 119 is anal, while in women 1 in 12 is seated in this locality. Statistics are wanting for this country, but my impression is that anal chancre among men is of the rarest. The usual seat of anal chancre is in the folds of the anal mucous membrane. These being put upon the stretch, the lesion may be discovered in the form of an elongated reddish ulcer. Occasionally, however, the chancre is minimal in size, a small, excoriated papule. Now and then it is large, cup-shaped, and excavated, with a well-marked, indurated base. Intra-anal chancre is generally of the fissured form. *Rectal chancre* is very rare, and can scarcely occur except as the result of unnatural intercourse. Anal chancre is usually indolent, very rarely exciting reflex spasm. This is a very important diagnostic sign, since simple fissures are usually accompanied by severe pain. In the lowest classes of women the anal chancre is sometimes "mixed." A not very infrequent complication is that of vegetations, which sometimes occur to a quite considerable size. Stricture of the rectum is rarely, if ever, the result of chancre. So-called chancreal strictures are usually due to gummatous or other late syphilitic lesions. Indurated engorgement of the external inguinal glands is a usual accompaniment of anal chancre; it appears early, and is usually bi-lateral.

CHANCRE OF THE MAMMARY REGION.—Chancre of the breast is one of the most important among extra-genital chancres. Although it may be contracted by contact with the mouth or even the genitals of another adult, it is by far the most frequently met with as the result of contagion from mucous patches on the lips of nursing infants.¹ This fact is of importance from a medico-legal point of view, and the characteristics of this lesion should therefore be borne in mind.

When seated outside of the nipple, mammary chancre can be diagnosed without difficulty. It shows itself as an erosion, or an eroded papule of some size, with or without a crust, roundish or ovalish, and resting upon an indurated base (Plate XVIII. Fig. 6). When, however, mammary chancre affects

¹ According to "Colles's law," which will be explained on a subsequent page in treating of the hereditary transmission of syphilis, the mother of an infant the subject of hereditary syphilis cannot contract the disease from her offspring.

the nipple, and especially when it is confined to the base of the nipple, it is sometimes difficult of diagnosis. Irregular in form, often very small, even like a slight fissure at times, and masked by a crust, it is very apt to be mistaken for some simple lesion, such as a chapped breast, a furuncle, or a simple erosion, a circumscribed eczema, or a bite or some other injury contracted in nursing. It should be remembered that mammary chancre is at times one of the slightest and apparently most inoffensive of lesions. Two symptoms, however, may usually be relied upon to decide the diagnosis, or at least to aid it materially. The first of these is the induration of the lesion, characteristic of chancre, and wanting in the other lesions liable to be mistaken for it. The second is the enlargement of the axillary glands, which is never wanting, and which presents the peculiarities of syphilitic adenopathy—the cold, hard, indolent condition. The indolent and comparatively painless character of the lesion is also of importance from a diagnostic point of view. When the patient suffering from supposed mammary chancre is a nursing woman, she should of course be confronted with the nursing, and a careful examination should be made of the latter, with the view of ascertaining the presence or absence of signs of syphilis.

DIGITAL CHANCRES.—A few words may be said with reference to chancre of the finger, which, though rare, yet does occur from time to time, and may go unrecognized to the injury of the patient, and to the danger of those with whom he may be brought into contact. The type of chancre of the finger commonly met with is the “*ulcus elevatum*.” Its evolution seems to be somewhat slower than that of chancre of the genitalia, the induration in particular lasting a long time. The commonest seat of chancre of the finger is at the side or base of the nail, or at its free margin. It begins as a papule, pustule, slight excoriation, or fissure. On examination, a deep-red, hard, elevated mass of moderate size is perceived, which when ulcerated yields a scanty, serous secretion. The borders of the nail may be thickened or superficially ulcerated, but the sore is confined to the soft parts—a point of distinction between chancre and syphilitic onychia. The entire distal phalanx is sometimes indurated, giving the finger a bulbous shape. The epitrochlear and axillary ganglia are usually enlarged, and moderate lymphangitis is sometimes present. Physicians and midwives are more apt than others to be affected with this form of chancre, and, especially in the case of midwives, the affection may be conveyed to others and very widely spread.¹

RELATIVE FREQUENCY OF CHANCRE AND CHANCROID.

The relative frequency of chancre and chancreoid is a matter demanding some notice. According to Belhomme and Martin,² the French statistics on this subject are so diverse that it is impossible to draw an average, one observer reporting four chancreoids to one chancre, while another meets with them in nearly equal numbers, and while others, especially of late years, find the proportion nearly reversed. (See Tables, pages 333, 334.) One thing is certain, namely, that among the upper classes chancre followed by syphilis is the commoner affection, while in the lower classes chancreoid is more frequently met with. In all probability chancreoid is destined to greater rarity as time goes on, and it is not rash to hope for its almost entire extinction in the not very remote future.³

¹ See Bardinet, *Syphilis communiquée par le doigt d'une sage femme*. Bulletin de l'Académie de Médecine, Avril, 1874.

² *Op. cit.*, p. 12.

³ See Bumstead and Taylor, *op. cit.*, p. 346.

LESIONS OCCURRING CONCOMITANTLY WITH CHANCRE.

LYMPHANGEITIS.—In one case out of five, according to Bassereau, the chancre is followed by inflammation of one or more lymphatic vessels in its neighborhood. These appear in the form of cordy indurations under the skin, more or less straight, or occasionally wavy and moniliform. Sometimes several parallel lymphatics are involved, giving the sensation of a ribband under the skin. It is only rarely, and when the inflammation is more severe, that the enlarged lymphatics can be traced by their color, which shows of a light red under the skin. This engorgement of the lymphatics is unaccompanied by fever, and patients sometimes fail to notice the change. At other times there is a slight sensation of weight and tension.

After three or four weeks, the lymphangeitis commonly disappears by resolution. Occasionally, however, like the induration of the chancre itself, this induration may last for six or eight months. In rare cases an abscess, followed by a lymphatic fistula, exuding a clear fluid, occurs in the course of the vessels. This often is healed only with difficulty. The richness of the genital region in lymphatics makes the occurrence of angeioleucitis much more common in chancres of these parts than it is in connection with extra-genital chancres. In men, the lymphatics of the dorsum penis are those most usually affected, and their long cord-like course can easily be followed to the pubes and to the groin. In women, the inflamed lymphatics are hidden in the tissues of the labia minora and majora, and run up toward the ganglia parallel to the genito-crural fold. They are also met with about the mons veneris in the form of knotty masses buried in the fatty tissues of the region. When they cannot be perceived by the touch, the presence of inflamed lymphatics in this region is often manifested by œdema of the mucous or mucocutaneous surface of the vulva.

ADENITIS.—Adenitis is in reality not a complication of chancre, but a necessary accompaniment. It occurs almost invariably; as Ricord used to say, "The bubo follows the chancre as the shadow follows the person."¹ Adenitis is, if not the most, at least one of the most important aids to the diagnosis of chancre, and its peculiar characteristics should be carefully noted.

The bubo symptomatic of chancre is found in the ganglia with which the lymphatics of the affected region are connected. If the chancre is seated on the genitalia, the glands of the groin are affected, but those of other regions, the submaxillary, for instance, remain unaffected. If the chancre is in the mouth, the submaxillary glands are enlarged, but those of the groin remain intact.

The following table, from Fournier, shows the seat of the bubo corresponding to chancres of various localities.

SEAT OF CHANCRE.	CORRESPONDING BUBO.
Genital chancres, that is, chancres of the penis, scrotum, labia majora and minora, fourchette, meatus urinarius, urethra, opening of the vagina, etc.	Inguinal ganglia.
Perigenital chancres: chancres of the perineum, genito-crural region, mons veneris, buttocks, thighs, etc.	Inguinal ganglia.

¹ Fournier, in 265 cases of chancre occurring in men, found adenitis in 263; in 223 cases of chancre observed in women, 220 showed concomitant adenitis.

SEAT OF CHANCRE.	CORRESPONDING BUBO.
Chancres of the anus and margin of the anus.	Inguinal ganglia.
Chancres of the lip and chin.	Submaxillary ganglia.
Chancres of the tongue.	Subhyoid ganglia.
Chancres of the eyelid.	Pre-auricular ganglion.
Chancres of the finger.	Epitrochlear ganglion; axillary ganglia.
Chancres of the arm.	Axillary ganglia.
Chancres of the breast.	Axillary and sometimes subpectoral ganglia.
Chancres of the cervix uteri.	Theoretically the pelvic ganglia; in general, no engorgement in the groins; exceptionally, inguinal bubo.

The induration of the ganglia begins about the same time as the induration of the base of the chancre. In rare cases the induration may be delayed, but, according to Ricord, never longer than a fortnight. Fournier, however, mentions one case where the ganglionic induration did not appear until twenty-seven days after the appearance of the chancre.

In adenitis accompanying chancre of the genitalia, the induration may affect the glands of either or both groins. It usually occurs on the same side as that upon which the chancre is situated. One or more glands may be affected. The "pleiad" of olive-shaped or globular tumors is felt, cartilaginous in hardness, freely movable on each other and the surrounding tissues, and without attachment to the overlying integument. One gland is usually more developed than the rest, and may be of almond size, while the others as large as a bean or a cherry surround it like satellites.

A marked peculiarity of the syphilitic adenitis accompanying chancre is its indolent character. The glandular enlargement takes place insidiously, often without the patient's knowledge. The skin remains unaltered, there is no pain, and only slight tenderness on pressure. The whole picture of "syphilitic bubo" is as widely different from that of chancreoid bubo as it is possible to imagine. (See article on Chancreoid, page 329.) Less frequently a single tumor is felt in the groin, and this may be somewhat larger than those above described. The various characteristics, however, remain the same.

Ganglionic induration is usually at its height within a week or two weeks. If mercury be given, it may diminish in degree, only to return when secondary or general symptoms show themselves. It may last from several weeks to five or six months, or longer. The adenitis of syphilis very rarely results in suppuration. Bassereau found only 16 cases of suppurating bubo in 383 cases of syphilis, while Fournier found but 2 in 265.

The importance of the non-suppurative character of syphilitic bubo, is seen in the investigation of cases where doubtful lesions, late in character, if syphilitic, show themselves. If the patient gives a history of venereal sores accompanied by non-suppurating buboes, syphilis may with great probability be inferred. If, on the other hand, the venereal sores were followed by suppurating buboes, the probability, though much less strong, is in favor of the occurrence of chancreoid. It is a common but not invariable rule that syphilis does not follow an open bubo.

Syphilitic adenitis is most apt to be confounded with strumous engorgement. The history of the case and the accompanying symptoms must decide the diagnosis. From simple inflammatory and virulent bubo, the indolent and non-inflammatory character of the lesion under consideration will distinguish it.¹

¹ See Auspitz, Buboes of the Inguinal Region. *Archiv für Dermatologie und Syphilis*, 1873. Translated in the *American Journal of Syphilography and Dermatology*, vol. v, 1874, pp. 131, 270.

DIAGNOSIS OF CHANCRE.

The diagnosis of chancre is sometimes easy, and at other times very difficult, but it is always a matter of great importance, both on account of the prognosis, and also on account of the treatment which is to be followed.

One of the first questions that suggests itself here is at what date can a positive diagnosis be reached. Patients not infrequently apply to the physician with an abrasion of recent date, perhaps not twenty-four hours old, demanding a categorical answer to the inquiry what may be the nature of the lesion. The answer to this can be of but one kind. It is impossible to say, at so early a date, what such a lesion may turn out to be. The most virulent chancre, leading to the most malignant form of general syphilis, is, in the earlier days of its appearance, one of the most benign of all lesions. A pin-scratch looks more threatening. In fact, where a mistake in diagnosis has been made, it has been, nine times out of ten, that the chancre has been mistaken for an abrasion. This fact should be kept in mind as giving a good notion of the ordinary appearance of a chancre when it first makes its appearance. It is not an ulcer; not a sore; it is an abrasion, or a scratch, to all appearance.

A little later, when the chancre has begun to differentiate itself from lesions of similar appearance, two diagnostic points of much value present themselves. These are *induration* and *glandular engorgement*. All other diagnostic signs are delusive. The contour of the lesion, its form, its color, the aspect of its surface, etc., are variable, inconstant, and not to be trusted. But palpation of the base of the suspected lesion will almost invariably reveal a peculiar resistance, a hardening of the tissues, which, when present, is an almost certain sign of chancre. No other lesion likely to be mistaken for chancre presents this firmness of base, though when caustics or irritants have been used, there is often developed an inflammatory induration which is with difficulty distinguished from the induration of chancre.¹ Again, if the suspected lesion is of some standing, at least one to two weeks, the presence of ganglionic engorgement, that is, of a group of small, bullet-like, indolently swollen glands in the groin, will indicate almost with certainty that it is a chancre.

Next to a simple abrasion or scratch, the lesion which is most likely to be mistaken for chancre, and *vice versâ*, is herpes genitalis. It is indeed often very difficult to distinguish between the two lesions. One of the first diagnostic signs is that herpes is almost always accompanied at its first appearance by heat or burning of a local character, while chancre is completely indolent and without sensation. This sign, though of value, depends upon the subjective sensations of the patient, and cannot, therefore, be entirely depended upon in many cases. More certain diagnostic signs are the condition of the ganglia, the presence or absence of induration, and the *outline of the lesion*. As to the ganglionic engorgement, this is not present where there are only one or two scattered lesions of herpes, but where the herpetic lesions are confluent and of some size, there is a ganglionic engorgement, differing from that of chancre, however, in being merely a slight sub-inflammatory tenseness of the ganglia. The induration of chancre is marked; that of herpes, in the unusual circumstance of its being present, is nothing more than a very slight inflammatory firmness of the underlying tissues. The outline of the lesion is strongly insisted upon by Fournier as one of the most satis-

¹ In investigating a suspected sore, the question should always be asked: "Has any application been made?"

factory and certain diagnostic differences between herpes and chancre. The contour of a chancre is represented either by a circle of a certain diameter, more or less; by an oval figure; or by an irregular geometrical outline. The contour of a large patch of herpes on the other hand is of a curiously figurate character, made up of a series of incomplete circles (Fig. 333). This

Fig. 333.



Outlines of chancre and herpes, showing polycyclic contour of herpetic lesions; a, chancre; b, herpes.

“polycyclic” form, as Fournier calls it, is not accidental; it results from the fusion of a number of independent circular lesions, and is pathognomonic of herpes. Of course chancre does not possess this peculiarity because it is not made up in the same manner.

To these diagnostic signs between herpes and chancre, which are to be depended upon when a conclusion is to be reached if possible at the first view, may be added another which requires time, I mean the ulterior evolution of the lesion, which is of course the criterion *par excellence*. If the lesion is herpes, repair quickly takes place, and rapid cicatrization, with no after symptoms. If, on the other hand, it is a chancre, the process of repair is in most cases a slower one. The lesion extends a little, or more frequently remains stationary as regards size, meanwhile assuming a more and more characteristic appearance, and the accompanying ganglionic enlargement shows itself unequivocally. Of course, all uncertainty is at an end when, after a few weeks, generalized symptoms make their appearance.

One cause of possible error must be alluded to at this point: it is the fortuitous coexistence of herpes and chancre in an identical locality. This is not as rare as might be supposed; in fact, Fournier says it is not uncommon in women. It may occur through the inoculation of the syphilitic virus upon an herpetic ulcer, or, on the other hand, an outbreak of herpes is sometimes induced as a result of the irritation of a chancre, and in its immediate neighborhood.

In the female, chancre may occasionally be confounded with erosive vulvitis, especially as this occurs in infants and young children.¹ Ordinarily the diffuse and superficial character of the vulvitis is sufficient to distinguish it from that circumscribed form which sometimes shows itself around a chancre. Now and then, however, instead of showing itself in the form of confluent and desquamative erosions, this form of vulvitis displays discrete and somewhat excavated lesions, of a bright red color or of a pultaceous gray aspect, and in these cases the affection resembles chancre so closely that it is almost impossible to distinguish the two affections at first sight. The importance of this, in a medico-legal point of view, in the case of infants and young children said to have been the subjects of criminal assault, is of course very great. Fournier says that in medico-legal cases he makes it an invari-

¹ See Gougenheim, Des Folliculites Vulvaires Externes. Ann. de Derm. et de Syph., 2me sér., t. iii., Avril, 1880.

able rule, "never to diagnosticate chancre by the chancre," that is, never to found his diagnosis upon the appearance of the lesion itself.

Fournier¹ gives the following illustrative case:—A little girl, six years of age, was brought to the hospital as being the subject of chancres said to have been communicated in an attempt at criminal assault. Examination showed intense vulvitis, the labia majora being swollen to the size of a quarter of an orange, œdematous, red, and painful, with abundant suppuration. In addition, there was erosive intertrigo of the genito-crural folds, and of the upper and inner portions of the thighs and inguinal regions, and three ulcers also could be seen upon the labia majora. One of these was the size of an apricot pit, the other two were circular and the size of lentils. These lesions were of a grayish color and covered with a diphtheritic looking membrane; they were shallow, with a flat surface, even a little raised in one lesion. They were indolent and had a somewhat indurated base. Finally, in both groins there were enlarged ganglia, indolent, multiple, and easily rolled under the finger.

With these lesions before him, Fournier unhesitatingly diagnosed chancre with vulvitis, but, in accordance with his rule in medico-legal cases, declined to express his opinion formally to the court of justice until after a delay of a few days. Fortunately for the accused, this delay changed entirely the aspect of affairs. Within a few days, under a simple dressing, the vulvitis and ulcers disappeared like magic, the ganglia lost their induration, and the patient recovered without showing any subsequent signs of infection, though remaining under careful daily observation at the hospital for several months.

I have given the account of this case because it shows in the most striking manner possible how the most distinguished living syphilologist could be completely mistaken in a diagnosis at first sight. In making this "confession" public, with characteristic candor, Fournier adds the following moral: (1.) The case demonstrates first, that certain simple, purely inflammatory lesions may take on the aspect—the mask and stamp, so to speak—of chancre, with such fidelity to the genuine lesion as to impose themselves upon the most attentive and experienced observer as the initial lesion of syphilis. (2.) It demonstrates, moreover, that the medico-legal diagnosis of chancre should not be made on a single examination of the lesion supposed to be such, but rather by the collation of confirmatory signs, of which the symptom first presented (chancre) should constitute the first term, and the secondary, generalized, constitutional symptoms following at a date named, should constitute the final term.

In considering the diagnosis of chancre thus far, the erosive and desquamative forms of the lesion have been kept in mind in connection with the other lesions with which these may be confounded. When, however, the chancre becomes more or less ulcerated (see Plate XVIII. Figs. 2 and 3), it is the chancroid with which it is most likely to be confused. The diagnosis between chancre and chancroid has been dealt with by Dr. Sturgis in the preceding Article (page 333.) and I shall therefore not dwell upon this subject at length, but shall content myself with giving the following table, based upon those furnished by Bellhomme and Martin and by Fournier, which shows in brief the various points to be considered in the differentiation of the two lesions, a task usually not very difficult.

DIFFERENTIAL DIAGNOSIS BETWEEN CHANCRE AND CHANCROID.

CHANCRE.

(1) Incubation on an average from fifteen to thirty-five days.

(2) Derived from the contagion of a chancre, of a secreting secondary syphilitic lesion, or, in some cases, of the blood of a person suffering with secondary syphilis.

CHANCROID.

(1) No incubation.

(2) Derived from the contagion of a chancroid or of a suppurating chancroidal bubo.

¹ Op. cit., 2e éd., p. 203.

CHANCRE.

- (3) Usually single, rarely multiple, never confluent.
- (4) Non-inoculable on the patient.

(5) Begins by a simple erosion, or in some cases by a papule.

(6) When fully developed, the chancre is a superficial ulceration with sloping edges melting insensibly into the surrounding tissues, the centre covered in part with false membrane, the border bright red, usually of regular outline. Very little suppuration.

(7) Chancre is rarely painful.

(8) In ninety-eight cases out of one hundred, induration of the base is present; an elastic induration, gristly, having none of the characters of an inflammatory induration.

(9) The lymphatic ganglia in the neighborhood enlarge, harden, and become gristly, without suppuration. The lymphatic vessels also become indurated at times.

(10) Chancre is a lesion which gives rise to very little local reaction; it tends to spontaneous cure; it ulcerates only slightly; it rarely takes on phagedæna or gangrene; it follows a regular course.

CHANCROID.

(3) Almost always multiple, often confluent.

(4) May be inoculated any number of times on the patient. The pus of the suppurating bubo is also inoculable.

(5) Begins by a vesico-pustule.

(6) When fully developed, the chancreoid is a somewhat deep ulcer, of which the base is covered with a sort of organic detritus mixed with pus. The edges are almost perpendicular, and sharply defined.

(7) Chancreoid is almost always painful.

(8) Chancreoid is often accompanied by inflammatory hardness, but never by syphilitic induration.

(9) Chancreoid is often accompanied by adenitis or lymphangitis of phlegmonous character, suppurating sometimes, and furnishing occasionally an inoculable pus.

(10) Chancreoid is a rather serious local lesion; it has a strong tendency to ulceration; it follows a very irregular course, and does not tend to cure as chancre does. Phagedæna and gangrene are relatively frequent complications of chancreoid.

Before leaving the subject of the diagnosis of chancre, attention must be called to a circumstance which may render this difficult or impossible at times, at least for a certain period, namely, the simultaneous occurrence of chancre and chancreoid upon the same individual. Though uncommon, yet this does happen from time to time, much more frequently with women, however, than with men. A prostitute having connection with a number of men within a short space of time can easily contract a chancre from one and a chancreoid from another, each running its course independently. Time and repeated observation will serve to differentiate the lesions in such cases.

With regard to the peculiar diagnostic points characteristic of the chancre in certain localities, as the urethra, breast, vagina, and cervix uteri, reference may be made to the account given of these lesions under the general description of chancre.¹

PROGNOSIS OF CHANCRE.—Regarded as a local manifestation, chancre is ordinarily not a serious lesion. In some cases, however, either owing to its location, or because of some complication, a very unusual circumstance, this lesion may affect the anatomical structure, or may interfere with the functions, of some organ, and may thus influence indirectly the general health. Thus phagedæna may give rise to mutilation of the glans, or to urethral fistula, in men; to loss of the clitoris, or to destruction of more or less of the labia, in women; and to rectal stricture in either sex. Somewhat commoner

¹ See also Ch. Mauriac, *Diagnostic du Chancre Syphilitique*. *Ann. de Derm. et de Syph.*, n. s., t. i., p. 738.

than these complications, however, and quite serious, are the interference with nutrition which may result from buccal chancres, and the hemorrhage which may occur in phagedæna.

The difficulty in mastication and the pain caused by the passage of food, occurring particularly when the chancre is situated on the dorsum of the tongue, together, possibly, with the ingestion of septic discharges from the ulcerated surface, sometimes induce voluntary abstinence on the part of patients. As a result of this, gastric and anæmic disturbances may eventuate, dangerous not merely in themselves, but as diminishing the resistance of the organism to the assaults of the constitutional infection.

As to hemorrhage, Ory¹ cites the case of a young girl who had a chancre of the upper lip, which became phagedænic and destroyed a considerable portion of the lip. Hemorrhage occurred repeatedly from the affected part, so that the patient became exsanguinous, and fell fainting on the least exertion. Her life was preserved only by the most assiduous care, and convalescence was extremely slow.

The question whether the benignity or malignity of an attack of syphilis depends upon the quality of the infective material in any given case, or upon the nature of the soil in which the seed has been sown, has often been discussed. The first view, that of varying malignity in different virus, has one apparent fact in its favor—that is, the gradual diminution in the severity of syphilis since its first malignant epidemic occurrence in the fifteenth and sixteenth centuries. Syphilis at the present day is, in its earlier periods at least, a much milder disease than in former times. It has been asserted that this is due to the gradual attenuation of the poison in its transmission from generation to generation; but I think it is quite as likely that improved hygiene and therapeutics have played the most important part in ameliorating the severity of the disease. Even at the present day, moreover, there are certain parts of the world, as Mexico and China, where malignant syphilis still shows itself.

The other view, namely, that the severity of the disease in any given case depends upon the soil in which it is planted—that is, the constitution of the patient as influenced by hereditary or acquired infirmities of one kind or another, and by hygienic surroundings—has more clinical testimony in its favor.

Jullien cites the case of a young woman who was contaminated by her husband just after confinement. The latter was suffering from a very slight attack of syphilis. The unfortunate wife, however, fared far otherwise. After an unusually short incubation, fifteen days, a chancre appeared which destroyed a large part of the vulva; and towards the third month, in spite of energetic treatment, gummatous tumors appeared in various places. In less than a year the face had been destroyed by supervening phagedænic ulcerations. Other cases might be cited, going to show that the severity of the disease depends upon the elaboration which the virus undergoes under the influence of the organism in which it has been implanted.

The period of incubation is to some extent an index of the probable gravity of the affection in any given case. The less resistance the organism offers, the quicker the entrance of the virus—the briefer, in consequence, the period of incubation, and usually, also, the more malignant the subsequent symptoms. The character of the initial lesion, the chancre itself, is by many authorities regarded as indicative of the probable future course of the disease. Benign chancres, it is said, are followed by benign eruptions, and by non-suppurative lesions of the various tissues; phagedænic chancres by severe pustular syphilodermata and ulcerations, and, at a later period, by exostoses, necrosis, and caries.

¹ In his Thesis, *L'Étiologie des Syphilides Malignes Précoces*. Paris, 1876.

I do not think that this can be rightly formulated as a law; there are too many exceptions. I have again and again observed severe syphilitic manifestations to follow the most benign and insignificant-looking chancres.

Among the various circumstances which may be mentioned as influencing the evolution of syphilis, the scrofulous or lymphatic temperament is perhaps one of the most important. "Dread syphilis occurring in blondes," says Diday. Old age, abuse of alcohol, debility from constitutional infirmity or from irregularity of life, pregnancy,¹ and mal-hygiene, are all elements of value in the prognosis of chancre.²

TREATMENT OF CHANCRE.—The abortive treatment of chancre—that is, its destruction with the view of preventing the subsequent development of general symptoms—has been discussed by syphilographers for many years without an unanimous opinion having been reached as to the desirability or the success of this procedure. At a time when the distinction between chancre and chancroid had not been clearly made out, such observers as Hunter and Ricord asserted that if the chancre were thoroughly cauterized before the fourth day after contagion, no constitutional symptoms would follow. But chancre does not make its appearance before the third week as a general thing, and almost never before the tenth day. Consequently, those chancres which were aborted on or before the fourth day after contagion, were not chancres at all, but something else—chancroids, herpes, etc. More recently several observers, among them Auspitz³ and Kölliker,⁴ have extirpated chancres by the knife; but when carefully analyzed, and the doubtful cases rejected, their statistics do not offer satisfactory evidence in favor of this form of the abortive treatment. They have failed to bring forward conclusive evidence, in connection with their successful cases, that constitutional syphilis would have appeared if extirpation had not been practised.⁵

With regard to the cauterization or extirpation of a chancre considered as a local lesion, I think that this should not be performed, unless when phagedæna is present. The lesion ordinarily tends to get well spontaneously, and irritative or too stimulating applications are apt only to arouse irritation, and to give trouble in the future. The simplest dressing is therefore the best.

Continence should always be urged upon the bearer of a chancre, whether male or female; not only to avoid the irritation resultant from coitus, but also, and still more, to prevent conveyance of contagion. Many men, when they have contracted a chancre, care but little whether they transmit it to others or not. Women also, with whom chancre is usually such a minimal lesion, often think that they are unlikely to convey disease by means of such a trifling sore, and thus the affection is spread. In advising such persons, it is as well, in view of the selfishness of human nature, to lay stress upon the possible injury which patients may inflict upon themselves, by indulging in sexual intercourse while bearing a chancre upon their genitals, rather than upon the harm which they may inflict upon others.

A strict regimen, including abstinence from wine or liquors, and in some instances from tobacco, should be followed out during the course of treatment.

¹ See Cernatesco, *De la Marche et de la Durée du Chancre Syphilitique et des Syphilides Vulvaires* pendant le cours de la Gestation. Paris, 1878.

² See Ch. Mauriac, *Prognostic et Traitement de la Syphilis Primitive*. Abstract in *Ann. de Derm. et de Syph.*, n. s., t. i., p. 295; from *La France Médicale*.

³ *Vierteljahrsschr. f. Derm. u. Syph.*, iv. 1877, 1 und 2, S. 101.

⁴ *Centralblatt f. Chirurgie*, Nov. 30, 1878, S. 801.

⁵ Among recent writers on this subject are Chadzynski, "Sur la valeur prophylactique de l'Excision de la Sclérose Syphilitique Initiale." *Ann. de Derm. et de Syph.*, n. s., t. i., p. 461; also, Primo Ferrari and Francesco Folinea, of whose papers Jullien has furnished abstracts in the same journal, p. 362.

Locally, the most scrupulous cleanliness must be observed, especially if the chancre is so situated as to be soiled by the excretions, as in the anus or vulva. Frequent warm baths are beneficial, especially if there is any tendency to irritation. The affected part should be protected from contact or rubbing with the neighboring parts, or with the clothing. In reality this is, in the majority of cases, all that is required. When the patient demands more active treatment, dilute solution of chlorinated soda, black wash, or some mild astringent powder, such as that of the oxide of zinc, may be prescribed. The fact is that in the majority of cases the chancre tends to a spontaneous cure, and only requires to be let alone in order to get well of itself. When the chancre is slightly painful, rest is to be prescribed, with frequent warm baths and sedative lotions, such as lead-water and laudanum; or the following ointment may be used, remembering that an ointment cannot conveniently be applied to a mucous surface, or in the balano-preputial fold:—

R.—Ung. hydrarg. ʒv.
 Ung. aquæ rosæ, ʒij.
 Tinct. opii, m. vj. M.

It would seem scarcely necessary to advise against the employment of stimulating or irritating remedies, did not experience show that these are daily employed by practitioners in the treatment of chancre. Touching with the nitrate-of-silver stick, or cauterizations with sulphate of copper, etc., are of no use, and are frequently harmful. Cauterization is only justifiable under two conditions: either to stimulate the surface of the chancre when this is sluggish, or tends to remain covered with a pseudo-membranous coating—when the nitrate-of-silver stick may be applied lightly at intervals of several days; or to repress exuberant granulations appearing during the process of repair.

Sometimes, after the chancre has healed, there remains behind an indurated lump, which is slow to disappear. The expectant treatment alone is proper in such a condition. Patients are frequently anxious for something to be done to hasten the removal of what is sometimes a deformity, and will urge the employment of stimulant applications, caustics, or even the knife. Interference, however, is not proper, as the result will probably prove very unsatisfactory. Fournier relates the case of a young man who had a chancre on the frænum of the prepuce, followed by a walnut-sized induration. Notwithstanding the assurance of Ricord and Fournier that it would disappear spontaneously in time, the patient induced some ignorant or unscrupulous practitioner to excise the lump. Violent hemorrhage followed, only checked by the actual cautery. Afterwards, a *larger lump than the preceding one* gradually took its place, and the patient only recovered after some months with the loss of a good part of his glans penis, all on account of a lesion which, let alone, would have disappeared without leaving a trace!

PERIOD OF THE GENERALIZED LESIONS OF SYPHILIS.

The various stages in the evolution of syphilis were formerly, and are still frequently, classified under three heads, primary, secondary, and tertiary. But, while the first two of these are distinctly separate, and divided the one from the other, it is not thus with the so-called secondary and tertiary periods, which possess no distinct line of demarcation in practice. I prefer therefore to consider all the lesions of syphilis following the chancre and its concomitants, under the comprehensive category of *generalized lesions*. For

the poison which has heretofore been confined, as to its outward manifestations, to a single locality and its immediate neighborhood, now diffuses and spreads itself about throughout the economy, and shows itself in the form of constitutional symptoms of various nature.

The term "constitutional syphilis" has sometimes been employed to designate the period under consideration, but I consider this term faulty, as implying a local character for the chancre, which indeed is as much a "constitutional" symptom as any that follow.

A further division of the generalized lesions into *early* and *late* may be made for convenience's sake, it being understood that this subdivision is not and cannot be accurate, the chronology of the various symptoms not being the same in every case, although their sequence is never inverted. For example, the erythematous, pustular, and gummatous syphilodermata occur in this order, and usually with certain intervals of time between the appearance of each. But, while in certain cases where the syphilitic attack tends to assume a malignant type, these eruptions follow one another in such rapid succession as to appear almost synchronously, yet they never appear in inverted order, and we never see a gummatous tumor followed by an erythematous syphiloderm.

GENERAL CONDITION BEFORE AND DURING THE OUTBREAK OF THE EARLY GENERALIZED SYMPTOMS.—The chancre, as has been said, is, for a time, the only manifestation which betrays the existence of syphilis. For a certain period, no other lesions show themselves to indicate that a virus is lurking in the system. This period of the "second incubation," as it is called by some authors, the second interlude in the drama of the evolution of syphilis, as Fournier graphically terms it, is followed by the explosion of generalized symptoms. Its duration is on an average forty-five to fifty days, although it may vary, in exceptional cases, as much as a week or ten days on either side of these figures.¹

Following this period of apparent repose, the generalized symptoms make their appearance in due chronological sequence, never appearing before the chancre, never appearing without the chancre having first appeared. There is no such thing as *syphilis d'emblée*, the sudden outbreak of generalized symptoms; a chancre, whether detected by the patient and physician, or whether eluding the closest scrutiny, has certainly, and of necessity, preceded any general outbreak.

CONDITION OF THE BLOOD IN SYPHILIS.—That the blood must undergo some change during the evolution of the syphilitic poison in the economy, has long been admitted, but the first scientific observations upon the subject were made by Grassi, under the direction of Ricord.² Grassi undertook a number of chemical analyses of the blood in persons suffering from venereal sores, and found that when these sores were not followed by subsequent syphilitic manifestations (chancreoid), the blood remained normal; while in cases where subsequent generalized symptoms resulted (chancre), the blood showed diminution of the globular mass with proportional increase of the albuminous constituents. Grassi's results were confirmed by Wilbouchewitch, of Moscow,³ who, desiring to study the influence of mercury on the composition of the blood,

¹ Of course this refers to untreated cases. Mercury given during the early stages of the disease retards the evolution of symptoms. In rare cases the second incubation may be longer; Keyes says as long as four or five months. (Op. cit., p. 101.)

² Leçons sur le Chancre, 2e éd., p. 184.

³ De l'influence des préparations mercurielles sur la richesse du sang en globules rouges et en globules blancs. Archives de Physiologie, pp. 509, 537, 1874.

commenced by inquiring into its condition before the administration of the drug, and during the existence of chancre.

In ten cases studied by Wilbouchewitch, the average diminution of red corpuscles was 638,870 (the normal figures being taken as from 4,200,000 to 6,477,000), while the increase in the white corpuscles was 550, the proportion being 1 white corpuscle to 448 red corpuscles, instead of 1 white to 530 red, the average normal proportion.

Of course this impoverished condition of the blood would be likely to lead to various characteristic symptoms, and thus we find in some cases disorders of circulation, irregularity in the action of the heart, murmurs in the larger vessels, pallor, epistaxis, and occasionally œdema of the lower extremities. In addition, general malaise, loss of energy, and a constant sense of fatigue; nervous symptoms, such as vertigo, insomnia, and headache, particularly of a temporo-frontal character; also vague and diffuse pains of various sorts—sometimes in the muscles, giving rise to simulated torticollis, pleurodynia, or lumbago—at other times concentrated in the joints or in the shafts of the long bones; in a word, any or all of the symptoms of an anæmic condition.

While these symptoms of anæmia are not well marked in every case of early syphilis, yet one or another is almost always present in cases of average severity.

SYPHILITIC FEVER.—There are few cases of syphilis which, if closely watched, will not show some febrile movement, and occasionally the fever plays a prominent part in the history of the case. It is sometimes the chief symptom which the patient recalls subsequently, when examined as to the early history of the disease. The fever of syphilis commonly makes its appearance from the fiftieth to the sixty-fifth day after contagion, perhaps on an average in from the third to the fifth week after the appearance of the chancre. Its outbreak is usually preceded by one or two days of headache and prostration, followed by a more or less violent chill. The temperature commonly varies from 100.4° to 102.2° F., but in some rare cases it may reach 104°, 104.9°, and even 105.4°. (Fournier indeed reports a case where the temperature reached 107°.)

Courteaux¹ describes three distinct varieties of syphilitic fever, as follows:—

(1) The *intermittent form*, comprising a series of isolated attacks with intervals of complete apyrexia, is the most common. These attacks resemble very closely those of malarial intermittent fever. They usually begin in the evening, and last about twelve hours, occasionally assuming a quotidian type, but more frequently following an irregular course. Although following the usual routine of chill, fever, and sweating, they do this in a less complete and less regular manner than is the case in malarial intermittent, the stages of chill and sweating being scarcely perceptible, and, in fact, rarely being noticed by patients, who complain of the fever only. What is commonly observed is continuous fever, broken transitorily by intermittent chills, the sweats also occurring from time to time during the attacks of fever. The spleen is not enlarged. *This form of syphilitic fever yields readily to the influence of mercury, but is entirely uninfluenced by quinine.*

¹ Thèse de Paris, 1871, written under the inspiration of Fournier. (Annales de Dermatologie et de Syphiligraphie, t. iii., p. 213.) In addition, reference may be made to the writings of Guntz (Das syphilitische Fieber. Leipsic, 1873); Bremer (Nordiskt med. Ark., 1874, and Gaz. Hebdomadaire, Mars, 1875); Vajda, Ueber das syphilitische Fieber und den Stoffwechsel syphilitischer (Vierteljahrsschr. f. Derm. u. Syph. 2te Jahrg., 1875, S. 147), and with annotations by R. W. Taylor (Archives of Dermatology, vol. iii., 1877, p. 162); and, finally, Fournier, op. cit., 2e éd., p. 643.

As the likelihood of mistaking malarial and syphilitic intermittent fever, one for the other, is very great, and as it is important to make the diagnosis when this is possible, I add the following table of comparative symptoms from Fournier :—¹

SYPHILITIC INTERMITTENT FEVER.

(1) Almost always quotidian, not assuming the tertian or other forms.

(2) Almost always nocturnal.

(3) Attack generally incomplete, not comprising the three classical stages, the stages of chill and sweating being usually absent, and the feverish stage most prominent.

(4) Attacks almost always irregular, the stages being confused or inverted, and the symptoms of the various stages associated.

(5) Attacks very variable as to form and general character, differing in one case from another, or in the same case at different times.

(6) Attacks usually briefer in duration than those of malarial intermittent, and frequently very short.

(7) Never enlargement of the spleen.

(8) Attacks rebellious to the influence of quinine, but yield readily to mercury.

MALARIAL INTERMITTENT FEVER.

(1) Sometimes quotidian, but more frequently tertian, especially in well-marked forms and at the beginning.

(2) Usually diurnal.

(3) Attack generally complete, that is to say, composed of three successive stages, each one presenting characteristic symptoms.

(4) Attack methodical as to evolution, each stage being clearly defined, and the stages succeeding one another with perfect regularity.

(5) Attacks generally uniform, and similar in one case to another, or in the same case at different times.

(6) Attacks generally somewhat protracted.

(7) Almost invariably appreciable increase in the size of the spleen.

(8) Attacks yield to quinine, but uninfluenced by mercury.

(2) The *continued form* of syphilitic fever, with exacerbations, is usually accompanied by general asthenia, sometimes giving it very much the aspect of typhoid fever. In other cases the temperature (104° F. and over), frequency of the pulse, extreme flushing of the face, headache, rachialgia, and general prostration, cause the attack to resemble the prodromic fever of variola so closely that even when a chancre has been detected, the diagnosis must be suspended until the fourth day. When, as occasionally happens, the outbreak of the small pustular syphiloderm occurs in the midst of the fever, the diagnosis becomes extremely difficult; and I have in several cases seen experienced and able practitioners entirely at fault for a time. The records of our smallpox hospitals tell a similar story, supposed cases of variola being admitted now and then during a smallpox epidemic, only to show undoubted syphilitic symptoms a few days later.

An important diagnostic point may be mentioned in this connection, namely, the normal performance of the more important functions of the economy in spite of the intensity of the morbid process. Frequently, for example, the appetite is preserved, the tongue retains its normal color, and the stools are regular in patients whose pulse beats at a high febrile rate. Gamberini has noted the absence of thirst, and Vajda has observed that the urinary deposits do not at all indicate the degree of mal-assimilation which would naturally be looked for with an elevated temperature. In addition there are no pectoral *râles*, such as often occur in typhoid; no lachrymation, no conjunctivitis, no coryza, as in rubeola; no angina, as in scarlet fever; no profuse sweats, as in rheumatic fever.

(3) The *ambiguous form* of syphilitic fever is much less frequent than the

¹ Op. cit., 2e éd., p. 656.

two former varieties. It is scarcely describable, passing and repassing from one form to another, from continuousness to intermittence, an intermittence capricious and indeterminate in character, and greatly prolonged.

Diagnosis of Syphilitic Fever.—The diagnosis between the intermittent type of syphilitic fever and malarial intermittent has already been dwelt upon. The continued forms of syphilitic fever may be mistaken for variola, as has been already said, and also for typhoid fever and rheumatism. The diagnosis from variola will be touched upon further in dealing with the papular and pustular syphilodermata, for it is only when these eruptions are present that the mistake is likely to be made. From typhoid fever, the absence of initial epistaxis, stupor of the countenance, intestinal disturbances (diarrhœa, gurgling in the iliac fossa, meteorism, etc.), buccal coating, bronchial râles, swelling of the spleen, rose-colored lenticular rash, etc., will distinguish syphilitic fever.

In a certain number of cases, where the syphilitic fever is accompanied by what Fournier calls "secondary pseudo-rheumatism," it simulates subacute rheumatic fever most closely, and the diagnosis can only be made after the most minute examination, bearing chiefly on the points of the correlative or independent occurrence of the febrile and articular symptoms; if these latter are or are not developed in a rheumatic subject and under the influence of an existent rheumatism; if they affect the characters of syphilitic joint-troubles¹ rather than those of common rheumatism; if they coincide with some symptoms of the same order but more distinctly syphilitic (as, for example, periostitis, periostosis, tenosynovitis, etc.). With these various points in mind, the diagnosis can in many cases be arrived at with some degree of certainty. Nevertheless, cases will arise in which it is simply impossible to distinguish between syphilitic fever accompanied by rheumatismal manifestations and ordinary rheumatism, at least until some symptom arises which is beyond doubt distinctive.

Prognosis of Syphilitic Fever.—The intermittent form of syphilitic fever is a comparatively unimportant manifestation of the disease, but the continuous variety, particularly when it extends over a considerable period of time, may lead to more or less serious nutritive disturbance. Patients sometimes fall into a state of anæmia, languor, and general atony, from which it is difficult to arouse them. In women, who are much more prone than men to suffer with the severer forms of syphilitic fever, this condition sometimes exists to a marked degree. It may be added that the severe forms of continuous syphilitic fever are apt to be followed at a later period by grave visceral syphilitic lesions.

Treatment of Syphilitic Fever.—Mercury, alone or combined with iodide of potassium, is the only satisfactory medicine which can be administered in syphilitic fever. Quinine, arsenic, etc., are entirely without specific value. The influence of mercury is, however, not uniform in all the varieties; while it is rapidly and certainly effective in the intermittent form, it is much less energetic and is slower in its action when given in the continuous variety. For this reason the dose should be double or triple that given in the inter-

¹ Fournier points out the following peculiarities of syphilitic joint-troubles: There is less acute and less inflammatory articular effusion—often, indeed, this is minimal and insignificant (many cases of articular syphilis are nothing more than simple arthralgia, without tumefaction, redness, effusion, or appreciable lesion); the articular attacks are more invariable, not as shifting nor as multiple as in rheumatism; there are very frequently nocturnal exacerbations; there are less marked general reaction, fewer sympathetic symptoms, absence of sweating and cardiac complications, etc.

mittent form of the disease. Mercury is usually well borne in syphilitic fever, and in the rare cases in which it is found to disagree when given by the stomach, it may be administered in the form of inunction.

AFFECTIONS OF THE LYMPHATIC GLANDS.—*Lymphangitis* may first be mentioned. In certain cases of syphilitic disease, delicate knotted cords, indicating the course of inflamed lymphatic vessels, can be perceived in the upper portions of the arms and thighs; they rarely extend towards the extremities. Jullien¹ reports the case of a woman who, three months subsequent to syphilitic infection, suffered with a general engorgement of all the lymphatic vessels and ganglia, coincident with the outbreak of a tubercular eruption. Ordinarily, lymphangitis tends to resolution, and, moreover, it is not a striking lesion; evidence of its presence must be sought for, as otherwise it is apt to escape attention. *Adenitis*, on the other hand, is more apparent and obvious. Few persons affected with syphilis fail to show symptoms of adenitis in the secondary period. In twenty cases observed by Campana (quoted by Jullien), the glands of the groin were affected in every instance, those of the sides of the neck in thirteen cases, those of the nucha in eight, those of the submaxillary region in five, those of the crural region in three, those of the axillary, the parotid, the epitrochlear, and the submammary regions each in two instances. These little glandular nodules are in every respect similar to those attendant upon chancre; they may occur independently of any tegumentary disturbance, and simply as the expression of the presence of the virus in the ganglia. The generalized involvement of the lymphatic glands always lasts a long time, and only disappears very slowly by resolution. Occasionally, in strumous subjects, a secondary serofulous inflammation may occur, resulting in the formation of the usual serofulous glandular abscess. The glands of the submaxillary, subhyoid, and cervical regions, those situated anteriorly and posteriorly to the sterno-mastoid muscle, and possibly also those of the retro-pharyngeal region, are most apt to be thus affected. As regards the influence of the appearance of these lymphatic disturbances on the general prognosis of the disease, it is unfavorable if the glandular enlargement is marked and intense.

CONDITION OF THE SPLEEN.—The spleen may be affected in the stage of syphilis of which we are treating, being sometimes enlarged to the extent of passing four or five inches above the floating ribs. This enlargement is observed in from 7 to 8 per cent. of all cases,² and is usually accompanied by gastric disturbances and enteritis, boulimia, and polydipsia; occasionally vomiting and diarrhœa supervene.

ENLARGEMENT OF THE TONSILS is not an infrequent accompaniment of this stage of syphilis, these glands sometimes attaining considerable size, and giving rise to one form of deafness occurring at this period.³

SUPRA-RENAL CAPSULES.—Jullien⁴ has drawn attention to the "pigmentary syphiloderm" (*vide infra*) as in all probability caused by syphilitic disease of the supra-renal capsules, of which the cortical portion at least is composed of lymphatic follicles.

¹ Op. cit., p. 643.

² Attention was first called to this subject by Weil, of Heidelberg. (Ueber das Vorkommen des Milztumors bei frischer Syphilis. Deutsches Archiv für klin. Med., Mai, 1874, and Centrabl. f. die med. Wissensch., 1874, No. 12.)

³ See Tanturri, Syphilitic lymphadenomata in the isthmus faucium. Rivista di Med., etc. Milano, Aprile, 1873.

⁴ Op. cit., p. 647.

AFFECTIONS OF THE OSSEOUS SYSTEM.—The close connection between the medulla of bone and the lymphatic elements of other portions of the system, has induced Jullien to offer disease of this tissue as an explanation of the osteocopic pains (ὀστέον, bone, and κόπτω, to strike or beat, or ὀστίον, bone, and κοπῶ, to weary) experienced at this stage of syphilis. The frequent occurrence of this symptom, its striking features, and its peculiar nocturnal exacerbation make it one of the most characteristic signs of the disease. In some cases no objective symptoms are noted, but more frequently the signs presented are those of periostitis. The pains are usually observed at an early period, sometimes showing themselves before the appearance of the eruption upon the skin. Patients complain of pains in various localities. The bones of the cranium—particularly the frontal—the ribs, sternum, and tibia, show various small, flat tumors, from one to two centimetres in diameter, raised, firm to the touch, and usually very tender and painful on pressure, even though spontaneously indolent. The frontal bone is, as has been said, the commonest seat of these pains; and the tenderness of the tissues is in some cases so acute at this point that patients cannot wear their hats. The middle portion of the ribs, and the lower third of the sternum, will generally be found to be the seat of greatest tenderness—the latter, indeed, offering an important aid to the diagnosis of syphilis on account of its very general occurrence. It has been suggested that the sensitive condition of the ribs will account, to some degree, for the occasional occurrence of that form of dyspnœa known as “syphilitic asthma,” which is now and then observed at this stage of syphilis. This early form of periostitis usually gets well of itself in the course of a month or six weeks; but now and then, in cases of malignant early syphilis, it goes on to necrosis.

Another form of early bone trouble, known as *periostosis*, consists essentially in the development of non-inflammatory lesions of a bony character. It is usually a very early symptom, and may be induced by a blow, causing at first a limited traumatic periostitis, which may subsequently develop into the syphilitic lesion.

As regards the common seats of these lesions, Popescu¹ gives the following table:—

Situatd on the frontal bone, in		.	.	.	27.9	per cent. of cases.
“	“ tibia,	.	.	.	16.3	“ “
“	“ ribs,	.	.	.	13.9	“ “
“	“ parietal bones,	.	.	.	9.3	“ “
“	“ ulna, radius, clavicle, lower					
	maxillary, sternum, each,	.			4.6	“ “
“	“ temporal, first metatarsal, fibula,					
	occiput, each	.	.	.	2.3	“ “

These tumors are painful upon pressure, and spontaneously through the night; the feeling is as if the points affected had been beaten. Frequently they are found beneath the scalp, preventing the use of the comb, and on the crest of the tibia, where they may be no larger than a split pea; these little bony tumors afford an important aid to the diagnosis of latent syphilis. Under the influence of treatment the lesions disappear, but untreated they may last indefinitely.

AFFECTIONS OF THE LIVER.—That form of icterus which is found occasionally in connection with the early eruptions of syphilis, has been described by Gubler, Foville, Lacombe, and Delavarenne.² It appears, however, according to the latter, that the essential morbid entity is in reality an affection of the liver, accompanied or not by icterus, which is thus reduced to its proper

¹ Thèse de Paris, 1873.

² Essai sur la Syphilis du Foie chez l'Adulte. Paris, 1879.

position of a symptom only. Early syphilitic disease of the liver shows itself either in the form of simple hypertrophy of this organ, or of hypertrophy accompanied by icterus, or pain, or both of these symptoms. It occurs in both sexes and at all ages, and usually shows itself from six weeks to two months subsequent to infection. The liver becomes enlarged to a very considerable degree, the entire organ being equally affected, and its surface remaining smooth and indurated. The average duration of the hypertrophy is from two and a half to three and a half months. In all reported cases which have been followed up, complete restoration of the liver to its normal volume has resulted.

Icterus is noticed in most cases of early syphilitic hepatic disease, but the cause of this symptom has not been satisfactorily explained. Jullien¹ believes it to be due to a catarrh of the bile-ducts, propagated from the gastro-intestinal canal, while Delavarenne attributes it to an infiltration of embryonic elements, due to the direct influence of the syphilitic poison, and giving rise to a more or less complete closure of the lumen of the ducts. In connection with the deposit of coloring matter in the skin, the conjunctiva, and the urine, other symptoms show themselves, such as gastric disturbance, diminution of appetite, occasionally slight febrile reaction, and almost always a certain degree of malaise and headache.

The occurrence of pain, which is usually experienced in connection with the hypertrophy of the liver accompanied by icterus, points to an inflammatory element in the morbid process. Sometimes discomfort alone is first observed, as a feeling of weight in the hypogastrium, soon developing into pain; at other times the pain, either spontaneous—when it is dull, and often intermittent—or provoked, as by percussion or manipulation—when it is acute—is observed from the beginning.

The concomitant symptoms of early syphilitic hypertrophy of the liver are important from a diagnostic point of view. Mucous patches of the throat, with erythematous or papular cutaneous lesions, are invariably found along with the hepatic disturbance. The icterus runs its course under treatment in about six weeks, but the hypertrophy does not ordinarily disappear in less than three months. The affection in itself is not grave, but it is considered to forebode a severe attack of syphilis, and is apt to recur subsequently in the form of more serious hepatic trouble. The treatment is that of syphilis generally.

DISTURBANCES OF THE URINARY FUNCTION.—*Albuminuria* has been noted in several cases as occurring in connection with early syphilis,² but, with perhaps occasional exceptions, the connection between the kidney affection and the constitutional disease has not been demonstrated.

Glycosuria, however, has been established as one of the accompanying symptoms of early syphilis, a number of cases having been reported³ where this symptom occurred concomitantly with early syphilitic eruptions, and disappeared, together with the skin lesions, under anti-syphilitic treatment.

DISTURBANCES OF THE UTERINE FUNCTIONS.—These are in many respects analogous to the disturbances to which ordinary anæmia gives rise in women,

¹ Op. cit., p. 652.

² Guioi, *Essai sur l'Albuminurie Syphilitique* (Thèse de Paris, 1867); Gailleton, *Albuminurie Syphilitique coïncidente avec des accidents secondaires* (Giornale Italiano delle Malattie Veneree, t. ii. p. 95, 1869).

³ Chiefly by Dub, of Prague (Präger Vierteljahrs. f. d. prakt. Heilk., 1863); Seegen (Der Diabetes mellitus auf Grundlage zahlreicher Beobachtungen. Berlin, 1875); and Servantie (Des Rapports du Diabète et de la Syphilis. Thèse de Paris, 1876).

and also to the conditions excited by the slow influence of certain toxic substances, such as lead. (Jullien.) *Leucorrhœa* and *uterine neuralgia*, together with *derangement of menstruation*, are among the commonest disturbances of the uterine functions. Menstrual disturbances, indeed, are almost always present in the graver forms of syphilis. It is well to keep this in mind, to prevent errors of diagnosis in cases of continued amenorrhœa under these circumstances.

The gravid uterus, however, feels most strongly the influence of the syphilitic virus. Unfortunately, the *syphilitic sterility* of some writers has no existence in fact, and syphilitic women only too often become pregnant while the disease is in full evolution. *Abortion* is one of the commonest results, and this has been explained upon three theories (Jullien): (1) By the direct action of the syphilitic virus upon the uterine fibres determining their contraction and the loosening of the membranes; (2) Congestion of the organ and consecutive asphyxia of the embryo; (3) Direct and primary poisoning of the fœtus by a morbid principle. The latter, Jullien considers the most probable.

Abortion is very common in early syphilis. Out of 390 pregnancies in syphilitic women, observed at the Lourcine Hospital, in Paris, 249 reached full term and 141 terminated in abortion or miscarriage; one case of death of the fœtus to every three pregnancies. The following striking case, noted by Fournier, may be cited in illustration of the effect of early syphilis upon pregnancy.

A woman had given birth successively to three fine children when she became infected with syphilis by her husband. Subsequently she had seven pregnancies. The first of these terminated at five months; the second at seven and a half months, the infant living twelve day; the third almost at full term, but the fœtus was dead; the fourth and fifth terminated in premature delivery of a dead infant; the sixth and seventh were interrupted at the third month and the sixth week.

When proper treatment is carefully followed out in these cases, the successive pregnancies become more nearly normal, until finally a living infant is born, which may die almost immediately with symptoms of syphilis; the next pregnancy may result in a living child who may survive with or without a certain degree of syphilitic cachexia; and finally a perfectly healthy child may be born. I have observed this succession of events in a number of cases, and have even noted some instances of mild syphilis where the lapse of years appeared to have extinguished the violence of the virus, and where even without treatment gradual restoration to the normal condition had taken place.

As to the time at which syphilitic infection must take place in order to give rise to abortion, if it occurs before the fourth month of pregnancy, abortion is almost inevitable. Occurring at a later date, the danger progressively diminishes. The occurrence of placental lesions as a cause of abortion will be touched upon further on. Fournier has called attention to the occurrence of *hydramnios* in pregnant syphilitics. According to Fournier, too, the anemia resulting from syphilitic infection predisposes also to *metrorrhagia* in the puerperal period. I have had occasion to confirm this observation in the case of a woman long under my care, in whom metrorrhagia has occurred repeatedly in several successive pregnancies, being in each instance cured by mercurials.

AFFECTIONS OF THE NERVOUS SYSTEM.—The affections of the nervous system in early syphilis are of two sorts: those due to the general cachectic condition of the system, and those brought about by mechanical irritation or pressure, as by enlarged ganglions or diseased bone. As has been said, the condition of the

system of some patients, during the early evolution of syphilis, is comparable to that induced by severe hemorrhages. There are *palpitation* of the heart, tendency to *syncope*, *asthenia*, *languor*, *loss of appetite*, etc., all of which are closely connected with nervous disturbance. In women, the various nervous manifestations of syphilis, from simple neuralgia to intellectual perversion of various kinds, are much commoner than in men. It is characteristic of all the various nervous disturbances of early syphilis, that they are essentially transitory. The later nervous manifestations show a very different aspect. *Sensory disturbances*, such as dizziness, dilatation of the pupils, amblyopia, ringing in the ear, earache, and deafness, are not uncommon. *Insomnia*, without any ascertainable cause, is also a nervous symptom occasionally observed.

The *cephalalgia* of early syphilis—by which is understood a deep-seated pain in the brain, and not the pain situated in the bony tissues or the meninges—is a common and stubborn symptom, occurring to a greater or less degree in almost every case of syphilitic disease. It is usually experienced in the frontal protuberances, the temples, or the occipital region. In its lightest forms it is only perceived as a feeling of discomfort, which does not prevent the patient from attending to his ordinary avocations. In a severer form, it takes the aspect of a headache, so severe as to interfere with mental occupation and to prevent sleep. In rare cases, it assumes extreme severity, causing agonizing and unbearable pain. Patients describe the sensation as of lancinating pain, or as if the head were being squeezed in a vise or struck by the blows of a hammer; the pain is continuous, but with nocturnal exacerbations. This form is rare. The intermittent variety is of more frequent occurrence. Here the pain comes on at the approach of night and passes off in the morning. Left to itself, the cephalalgia of early syphilis may pass away in a few days, or it may last indefinitely. Mercury exercises a complete mastery over it, and, vigorously employed, will bring speedy and complete relief. It is best given in the form of fractional doses of calomel, or by inunction, by which method its effects are most rapidly produced. (See under the general treatment of syphilis.) Iodide of potassium is also useful.

The general disturbance of the system caused by syphilis often induces the outbreak of some *latent neurosis*, or the *exasperation* of a *pre-existing neurosis*. This is especially the case with hysterical and epileptic patients. Occasionally the syphilitic poison develops hysteria or epilepsy in individuals previously completely exempt from either of those nervous affections. *Hysteria* may suddenly appear, with all the usual symptoms of fixed or erratic painful sensations, loss of strength, syncope, spasms, and convulsive crises. *Epilepsy* of a transitory character, but presenting no especially characteristic symptoms to denote its origin, may also develop. The diagnosis in this latter case is difficult, but it should be borne in mind that all cases of epilepsy, occurring for the first time at adult age without any perceptible cause, must be strongly suspected to be of syphilitic origin. In addition, however, it should be remarked, as indicating the syphilitic origin of this manifestation, that the crisis is incomplete, and the spasm limited to a single side. The coexistence of other cerebral symptoms, particularly cephalalgia, and of characteristic cutaneous eruptions, will also point to the true nature of the affection. Epilepsy is not very rare in early syphilis; Diday and Little have observed it in the third and fourth month respectively. The exact pathological character of the lesions which give rise to these cerebral symptoms has not as yet been ascertained. They are to be distinguished from the later syphilitic brain-troubles which will be discussed further on in this article.

Analgesia, general, or more frequently in scattered areas, is one of the curious nervous phenomena which are met with in the early stage of syphilis. It is a somewhat rare affection, and is almost always symmetrical. It may

be sought for on the extensor surfaces of the limbs, on the dorsal aspects of the forearms, and, above all, over the metacarpus, where it may be found alone in some cases, but where it almost always exists when it also occurs elsewhere. The cheeks and the mammary region are often affected by this peculiar insensibility, which may also extend to the mucous orifices of the body. At these points, even a deep prick with a sharp instrument is perceived only as contact, without giving the least pain. Tactile sensibility is usually present to a normal degree over the analgesic areas.¹ *Anæsthesia* is much rarer than analgesia, and never occurs alone. Fournier notes several other disturbances of sensation, such as *thermo-anæsthesia* (he gives the case of a patient who burned himself severely with a red-hot iron, not perceiving its temperature by the touch), *muscular analgesia*, and even *abolition of the muscular sense*. Patients in this last condition cannot perceive motion or rest, and only know by ocular examination when the position of their limbs has been changed. Of course, all these peculiar nervous disturbances are very rare.

The *sympathetic system* is also involved in some cases. *Algidity*, with depression of the surface temperature, which may descend to 82.4°, 78.8°, 77°, or even to 73.4° F., is occasionally observed. The extremities are cyanosed, and feel like ice; the pulse suddenly becomes filiform, and creeping chills are experienced. The depression is most marked at night. Sometimes sensations of heat are observed, coming in puffs about the head and spreading down through the body to the extremities. Still rarer is the occurrence of *hyperidrosis*, generalized and intermittent sweats, usually nocturnal or following slight fatigue; occasionally profuse perspiration of the extremities alone is observed.

In all these cases the pathology is a matter of pure conjecture. Nothing is known of the organic changes which induce the various morbid phenomena observed clinically.

Neuralgia in early syphilis is usually localized in the frontal and suborbital branches of the trigeminal; it is usually worse at night, and may easily be mistaken for the deep cephalalgia above described, or for the pain symptomatic of cranial bone-trouble. Among the other nerves which are sometimes affected, may be mentioned the lingual, auricular, mastoid, great occipital, lumbo-abdominal, crural, and sciatic, the latter usually being attacked in part of its course only. When the intercostals are affected, the neuralgia may contribute to the occurrence of "syphilitic asthma," and when their branches running to the mammaræ are involved, mastodynia ensues—a not uncommon, but most painful and stubborn symptom. Sometimes neuralgia is the first, and, for a time, the only, symptom of generalized syphilis. In all cases of mysterious and rebellious neuralgia, mercurials should be exhibited. The rapid disappearance of the painful symptoms under their use will furnish the best touchstone of the presence of syphilis, and a test of which the use in such cases is justifiable.

The various forms of *paralysis* observed in early syphilis are also remarkable for the rapidity with which they yield to mercury and iodide of potassium. In connection with the facial nerve, *akinesia* is frequently observed; inertia or immobility of the muscles connected with expression, labial deviation, and depression of the cheek and of the corresponding side of the nares, are among the commonest symptoms of this affection, which often supervenes at a very early date.²

Hemiplegia is a rare but sometimes-encountered affection of the latter

¹ See Wigglesworth, Analgesia in Secondary Syphilis (Boston Med. and Surg. Jour., April 14, 1870).

² Balmano (Gaz. des Hôpitaux, 1863, p. 582) has reported a case where facial palsy supervened a month after the infecting coitus, and on the seventh day of the erythematous eruption.

stages of early syphilis, occurring toward the sixth month, preceded by headache, often accompanying a fresh cutaneous outbreak, and going on to gradual development of the characteristic symptoms, without impairment of the intellect. Treatment in these cases should be prompt and vigorous. Administered in good time, specific medication is followed by rapid amelioration of the various symptoms, but a delay of even a week before beginning treatment may lead to very slow cure.

Other nervous affections, such as paraplegia, aphasia, meningitis, and the various myelopathies, may occur in the early periods of syphilis, but as the symptoms then presented in no way differ from those displayed by the same affections when occurring late in the course of the disease, reference may be made to their description further on.¹

LESIONS OF THE ARTICULATIONS AND OF THE SYNOVIAL CAVITIES OF THE TENDONS.—Described by the early syphilographers, the study of these lesions appears to have been overlooked in more modern times until a comparatively recent period. Richet,² about 1851–3, recalled attention to the occurrence of *syphilitic synovitis*, and the transitory lesions of the articulations have since been studied by Lancereaux³ and Vaffier.⁴

One syphilitic in ten, among men, and a greater proportion among women, suffers even during the first prodromic period, before the appearance of the chancre, with vague rheumatoid pains, worse at night, and aggravated by rest in bed while somewhat lessened during exercise. These are still more commonly found in the early stage of generalized lesions. They begin by a period of general lassitude and fatigue, particularly upon waking in the morning; the limbs seem stiff, and are moved with difficulty; rest in bed is more tiresome than standing. At a later period actual pain supervenes, with morbid sensitiveness on pressure, in the wrists, shoulders, knees, or ankles. The generalized eruption appears at this time. Under the influence of specific treatment, or even spontaneously, these symptoms disappear, leaving occasionally some slight creaking in the joints.

Poly-arthritis of a subacute character may occur after eight or ten days of prodromic joint pains. It resembles ordinary rheumatism so closely that it

¹ The following references are given to facilitate the further study of this very interesting series of nervous phenomena of early syphilis:—

Fournier, *La Syphilis du Cerveau*. Paris, 1879.

Castlenau, *Nevralgie Syphilitique*. Cazenave's *Annales*, t. i. p. 212.

Marty, *Paralysie du facial au début de la Syphilis*. *Gaz. des Hôpitaux*, 1863, p. 473.

Diday, *Épilepsie Syphilitique*. *Giornale delle Malattie Veneree*, t. iii. p. 46, 1867.

Gros and Lancereaux, *Des Affections Nerveuses Syphilitiques*. Paris, 1861.

Little, *Epilepsy of Syphilitic Origin*. *Med. Press and Circular*, 1868.

Mavreyeni, *Scelotirbe sifilitico*; guarigione. *Gaz. Méd. d'Orient*, 1868.

Fournier, *De l'Analgesie Syphilitique secondaire*. *Annales de Dermatol. et de Syph.*, t. i., 1869, p. 486.

Soresina, *Sifilide del sistema nervoso*; macchie pigmentali su tutta la persona. *Giornale Ital. delle Malattie Veneree*, t. ii., 1869, p. 87.

Moustapha-Faid, *Troubles de la Sensibilité*; *Analgesie Syphilitique*. *Annales de Dermatol. et de Syph.*, t. iii. p. 318.

Aparico, *Tremblement Syphilitique*. Thèse de Paris, 1872.

Gay, *Cases of Secondary Cerebral Syphilis*. *Annales de Dermatol. et de Syph.*, t. v., 1873, p. 469.

Bruberger, *Ein Fall von Meningitis syphilitica nebst Bemerkungen über Syphilis der central Organs*. *Archiv f. path. Anat. (Virchow)*, Bd. xl., S. 235, 298.

Mauriac, *Mémoire sur les Affections Syphilitiques Précoces des Centres Nerveuses*. *Ann. de Dermatol. et de Syph.*, t. vi., 1875, pp. 161, 265, 354, 427.

Finger, *Ueber eine constante nervöse Störung bei florider Syphilis der Secundärperiode*. *Vierteljahrsschr. Derm. u. Syph.* viii. Jahrg., 1881, S. 255.

² *Mémoire sur les Tumeurs blanches*. *Mém. de l'Acad. de Méd.*, t. xvii. Paris, 1853.

³ *Mémoire communiqué à la Société de Chirurgie*, Sept. 1863.

⁴ *Rhumatisme Syphilitique*. Thèse de Paris, 1875.

has sometimes been questioned whether it is not a coincidence of this affection with syphilis.¹ But the absence of profuse sweating and of visceral symptoms, the presence of simultaneous affections of the serous sacs, and the long duration of the morbid condition, together with the obstinate resistance of the affection to ordinary remedies and its yielding to specific treatment, all speak in favor of a syphilitic origin for this form of articular trouble.

Arthritis with effusion, or *hydrarthrosis*, is a later lesion than the preceding, and may even occur two or three years after the appearance of the initial lesion. Its beginning is not accompanied by pain, and the intra-articular effusion may attain a considerable volume before the patient's attention is drawn to it. When this occurs in the knee-joint, nothing except its size and a slight difficulty in walking denotes the presence of articular disease. The knee of one side alone is most generally attacked.

When the nature of the joint trouble is discovered in time, the mercurial treatment causes it to disappear with great rapidity, but when untreated, considerable thickening of the synovial tissues may take place, a thick secretion may be poured out, and a true syphilitic tumor may ensue, of a character to be treated of under the head of late syphilitic affections of the joints.²

The *tendinous sheaths* and *serous bursæ* are sometimes affected in early syphilis. In one variety of these affections, there is effusion into the serous sac surrounding the extensor tendons of the fingers, without tenderness or inflammatory symptoms, forming a sharply circumscribed, flattened, triangular tumor, with the apex towards the fingers, occupying the carpo-metacarpal region without extending beyond the transverse dorsal ligament. There is slight pain on pressure, with some little difficulty and weakness in the movements of the wrist. The occurrence of this affection in connection with the generalized skin symptoms of syphilis, and its rapid disappearance under the influence of specific treatment, will serve to establish the diagnosis. The prognosis is favorable.

The somewhat similar affection known as *acute hydropsy* of the tendinous sheaths gives rise to considerable pain spontaneously or upon pressure. This form commonly occurs³ in the shoulder, knee, and instep, where the synovial sacs are numerous, and also on the posterior aspect of the olecranon and on that of the calcaneum; it may, in fact, occur wherever there are tendons with attached synovial bursæ. *Hygroma* is a similar manifestation of early syphilis.

MUSCULAR CONTRACTION.—This is one of the most puzzling of the affections of early syphilis, and particularly so because its pathology is absolutely unknown. No lesion is known to account for the peculiar symptoms presented.⁴ These commonly affect the flexor muscles of the arm, although others are occasionally involved. The movement of the forearm upon the arm begins, without pain or other symptom, to become gradually less free, and, as if forced by an irresistible power, the forearm becomes flexed in an obtuse angle upon

¹ Baumler, and Duffin (Cases of Syphilitic Rheumatism. Trans. Clin. Soc. London, 1869, vol. ii. p. 81) have described these forms at length.

² See Fournier on the affections of the apparatus of locomotion in the secondary period of syphilis. Union Méd. de Paris, 1873, Nos. 21, 25, 28, 46, 48, 49.

³ Important contributions to this subject are the papers of Verneuil, Hydropisie des Gaines Tendineuses dans la Syphilis (Gaz. Hebdom., 1868, p. 609); and Fournier, Note sur les Lésions des Gaines Tendineuses. Paris, 1868. (Reprint from Gaz. Hebdom., p. 645.) Vaffier also describes this lesion (op. cit.).

⁴ The best and fullest description of this affection is that given by Mauriac in his prolix but important monograph, Des Myopathies Syphilitiques, Paris, 1877; a reprint of articles appearing in the Annales de Dermatologie et de Syphiligraphie, t. vii., 1876.

the arm to a greater or less degree,¹ and extension becomes impossible, although further flexure may be performed in some cases, while in others complete ankylosis exists. No lesion or alteration can be perceived in the size, shape, or appearance of the tissues involved. The tendon of the biceps, the muscle involved, is tense and hard as iron. Forceful extension has been made in some cases. This causes much pain and does no good, the muscle gradually contracting again as soon as the force is removed, until the forearm assumes its former position of flexion.

While the biceps brachii is the muscle usually implicated, the flexors of the leg may be involved, or the muscles of the jaw may contract, and give rise to a condition of "lock-jaw;" those of the neck may give rise by their contraction to a sort of torticollis; strabismus may be caused by contraction of the muscles of the eyeball; and lumbago, with incurvation of the trunk, by involvement of the sacro-lumbar muscles. Writers² have even described constrictions of the trachea, œsophagus, and rectum, as well as asthma, as the result of syphilitic involvement of the various muscles concerned; but these observations have as yet lacked confirmation, although there is nothing intrinsically improbable in the occurrence of these affections under such circumstances.

Syphilitic contraction of the muscles is commonly rather a late affection,³ but it may occur simultaneously with the earlier manifestations of syphilis. The duration of syphilitic muscular contraction depends entirely upon its treatment. Under the employment of specific remedies it disappears sometimes with great rapidity, at other times more slowly.

INFLUENCE OF THE GENERAL SYPHILITIC CONDITION UPON INTERCURRENT AFFECTIONS.—It is generally believed that the various internal affections with which the patient may chance to be affected while the syphilitic disease is active in his constitution, are more or less influenced thereby. Exact observations bearing upon this point are, however, wanting. Regarding the influence of syphilitic disease on traumatic affections, our knowledge is more exact, and this point will be found treated of in another part of the present work.⁴ (See Vol. I. p. 323.)

THE SYPHILODERMATA.

The syphilitic eruptions of the skin are characterized by certain peculiarities which they possess in common, and which serve to differentiate them from other skin affections. These are as follows: 1. Polymorphism; 2. Peculiar color; 3. Rounded form; 4. Apyretic, indolent, apruriginous character; 5. Amenability to the curative influence of mercury.

Polymorphism is the peculiar feature of the early syphilitic skin affections. They are often made up of various eruptive lesions: an erythematous syphiloderm may occur in connection with groups of papular lesions,⁵ and papulo-squamous eruptions may show mingled pustules or crusted lesions. Occasionally a patient will show, on careful examination, macules, dry and moist

¹ In three cases which came under my observation (Three Cases of Syphilitic Muscular Contraction, Am. Jour. Med. Soc., 1879), the arm was flexed at the angle of 165°, 150°, and 135° in each case respectively.

² Bouisson, *Tumeurs Syphilitiques des Muscles* (Annales de Cazenave, t. iii. p. 52, 1850), and Davasse.

³ In one of my cases the contraction manifested itself in the seventh month; in the other two, between the twelfth and the fourteenth months of the disease.

⁴ Jullien, *op. cit.*, p. 670, goes into the subject with some fulness, and adds references to a number of recent articles bearing upon the matter under consideration.

⁵ See illustration of Infantile Syphilis, Pl. XXIII., Fig. 1.

papules, scales, vesico-pustules, pustules, crusts, etc., all associated together.¹ It is quite different with non-syphilitic skin eruptions, which are usually found possessing a tolerably uniform character throughout. Thus in the eruptive fevers, the type of the eruption prevails over all the affected parts; in erythema simplex, the eruption is erythematous; in purpura, macular; in herpes, vesicular, etc. These points are often of great diagnostic value, but it must be remembered that there are numerous exceptions to the rule, both in syphilitic and in non-syphilitic eruptions, so that this symptom is not to be invariably depended upon.

The *peculiar color* of syphilitic eruptions has at all periods arrested the attention of observers. It is a very striking color, varying in tint according to the subject, the stage of the disease, and the locality. In some cases it is brownish-red—precisely the shade of lean ham; in other instances it is a brighter, slightly yellowish shade of red, resembling the color of a freshly cut surface of copper. The former color is more apt to be observed in lesions of the lower extremities, while the coppery hue is peculiarly characteristic of some forms of tubercular syphiloderma occurring about the face. Though sometimes of service in aiding in the diagnosis of a doubtful case, too much stress must not be laid upon the diagnostic value of color, since the syphilodermata do not always present it, while it is occasionally found in non-syphilitic skin diseases.

The *peculiar, rounded, or circinate* form or arrangement of the syphilitic skin lesion or group of lesions is, when present, of importance from a diagnostic point of view. The syphilitic lesion itself is almost invariably rounded in form, and, when grouped, the various lesions are very apt to assume a diadem-like arrangement, or that of a crescent, or of the arc of a circle of greater or less extent. Like the polymorphism and the color of the syphilodermata, this characteristic is not invariably to be depended upon, but is often a valuable aid to diagnosis in obscure cases.

The *apyretic, indolent, apruriginous* nature of the syphilitic eruptions is a very marked feature in their character. This alone differentiates them from the entire class of acute and febrile exanthemata, and particularly from the eruptive fevers, in which, as is known, the skin lesions make their appearance and are developed with the accompaniment of fever, together with inflammatory symptoms, and run a transitory career. It is true that some of the syphilodermata, and notably the early general eruptions, are occasionally accompanied in their early development by more or less fever. This, however, is not only uncommon, but, when the febrile movement does occur in connection with the outbreak upon the skin, the temperature does not rise to a high degree, and it very often quickly falls again.

Fournier cites a curious case occurring under the care of a distinguished colleague, where a patient was admitted to hospital with high fever, together with other symptoms which caused the diagnosis of *typhoid fever* to be reached. Forty-eight hours afterwards, numerous small rose-colored, slightly raised papules made their appearance over the whole body, when the diagnosis was changed to *smallpox*. But instead of becoming transformed into vesicles and pustules, these papules simply continued to grow in size and to alter gradually in appearance, until, at length, it came to be seen that beyond a doubt the affection was syphilitic. The fever meanwhile had disappeared.

Once fully developed, the syphilodermata run their course absolutely without any accompanying fever or inflammatory symptoms of any sort.² They are also quite indolent and sluggish in their course, the lesions remain-

¹ This does not refer to the late syphilodermata, which usually preserve a single type only.

² Excepting the occasional development of erysipelas, which I have not infrequently observed in connection with the development of gummata.

ing often for weeks and months without change; in fact, untreated, certain syphilitic eruptions may last unchanged for years. Of course, this peculiarity of the syphilodermata differentiates them sharply from the various eruptive fevers, and from the febrile pseudo-exanthemata, the spontaneous evolution of which is always rapid, and their duration comparatively ephemeral.

The syphilodermata are usually *apruriginous*, in fact, without any sensation of any kind. It not infrequently happens with regard to the early eruptions, and particularly in the case of the erythematous eruptions, that the patient's attention is first called to the existence of the affection by the physician who is examining him. Occasionally the early syphilitic eruptions do itch a little, especially when they first make their appearance. Patients are not often driven to scratch, however, as is the case in the other eruptions for which they might be mistaken.

The syphilodermata, or some of them, when they affect the scalp, axillæ, sternal region, anterior aspect of the limbs, etc., are likely in some cases to excite a certain amount of pruritus. I had under my care some time ago a woman suffering from an eczematiform eruption of the scalp (see under Vesicular Syphiloderm), who suffered from intense pruritus during the entire course of the affection. Pruritus, however, is very rare in any case.

The syphilodermata are all amenable to the influence of mercury. This fact, which has been known since the end of the fifteenth century, is now settled beyond question. Occasionally a syphiloderm may for a time appear rebellious to the influence of mercury, but, on the other hand, a questionable eruption which yields to this touchstone¹ may with certainty be regarded as of syphilitic origin.²

CLASSIFICATION OF THE SYPHILODERMATA.

The syphilodermata are classified according to their pathological character as follows:—

- I. ERYTHEMATOUS.
- II. PAPULAR.
 - (a) Small papular.
 - (b) Large papular.
 - (c) Moist papular.
 - (d) Vegetating papular.
 - (e) Papulo-squamous.
- III. VESICULAR.
- IV. PUSTULAR.
 - (a) Small acuminated pustular.
 - (b) Large acuminated pustular.
 - (c) Small flat pustular.
 - (d) Large flat pustular.
- V. TUBERCULAR.
 - (a) Tubercular serpiginous.
 - (b) Tubercular vegetating.
- VI. GUMMATOUS.
- VII. BULLOUS.
- VIII. PIGMENTARY.

¹ This touchstone of treatment should, however, be reserved only for cases where the diagnosis remains uncertain after every effort to make it out from the symptoms.

² The clearest and most satisfactory description of the syphilodermata in the English language is to be found in Dühring's *Treatise on Diseases of the Skin*, 2d ed., p. 470 et seq. Fournier, *op. cit.*, 2e éd., p. 258 et seq., gives the fullest account of these lesions with which I am acquainted.

In the following pages the various syphilitic affections of the skin will be treated of under the headings above given. It was formerly the custom to regard certain classes of the syphilodermata as belonging to "secondary syphilis," while others were considered as "tertiary" manifestations. But as in practice it is often found that the different eruptions appear at an earlier or later date than that assigned to them, thus confusing the mind regarding the stage of the disease in any given case, I have preferred to adhere simply to the pathological classification, indicating under the various classes of syphilodermata the date at which each commonly makes its appearance.

ERYTHEMATOUS SYPHILODERM.

The erythematous syphiloderm is the earliest and one of the commonest skin manifestations of syphilis. Although so common that few patients escape it, yet it is so entirely without subjective symptoms, and so apt to be confined to those parts of the body which are covered with the clothing, that it very frequently comes and goes unnoticed. In the lower classes and in hospital practice it is indeed so seldom noticed, that, were not the opposite fact well confirmed by other observations, it would seem to be one of the rarest skin affections in syphilis.

The erythematous syphiloderm commonly makes its appearance as the initiatory lesion of generalized syphilis, about the sixth or eighth week after the appearance of the chancre (on an average on the forty-fifth day). Occasionally, however, it may appear at a much later date, even toward the end of the first or the beginning of the second year, when its advent has been hindered by mercurial treatment. Under these circumstances the eruption displays somewhat different features from those presented when it appears at what may be called its normal period.

The erythematous syphiloderm presents itself in the form of diffuse macules or colored patches, of from pin-head to small-coin size, irregularly rounded, oval, or of various shapes.¹ Sometimes a number of lesions coalesce to form a large patch. At first the lesions are of a pale rose-color, afterwards the color deepens, and, as the eruption begins to pigment and pass away, it assumes a yellowish-brown tint, and then a brownish color. The macule at first disappear under pressure, but when pigmentation occurs they are persistent. As has been said, the eruption gives rise to no subjective sensations. The distribution of the erythematous syphiloderm is irregular. It is less apt than any of the other syphilitic skin lesions to assume a circinate form. The regions of the body usually attacked by it are the flanks and lateral portions of the thorax, the abdomen, chest, and back. The eruption is also frequently observed upon the flexor surfaces of the limbs. It is rarely observed upon the face, excepting over the forehead at the edge of the scalp, and only very exceptionally upon the hands.

Fournier² describes two special varieties of erythematous syphiloderm, one urticaria-like, and the other circinate. The latter is one of the later syphilitic skin manifestations, appearing toward the end of the first year or in the course of the second or third year. It may even occur at a still later stage when a course of mercurial treatment has been pursued. The circinate form is a very marked feature; circles or parts of circles, figures-of-8, etc., are often observed. Sometimes the circles are of quite a large diameter, even two or three inches. Usually they are from half an inch to an inch in diameter. This variety, if left without treatment, may last a long time. Mercury quickly cures it, but the disease is apt to recur. The circinate form of the erythematous syphil-

¹ See Duhring's Atlas of Skin Diseases, Pl. 1.

² Op. cit., 2e éd. p. 277.

oderm is liable to be mistaken for *erythema annulare, gyratum, or marginatum*. The eruption of the latter affection, however, is more methodically arranged; it is of a deeper red color, is raised above the surface, is most apt to occur on the backs of the hands and feet, is more ephemeral, and is likely to be found during the spring and autumn.

The *diagnosis* of the erythematous syphiloderm is usually not difficult. It is commonly accompanied by some of the other symptoms of syphilitic infection, general malaise, nocturnal headache, wandering pains in the limbs, sore throat, etc., while not infrequently the traces of the chancre and the involvement of the inguinal and other glands can be made out.

DIFFERENTIAL DIAGNOSIS BETWEEN THE ERYTHEMATOUS SYPHILODERM AND SIMPLE ERYTHEMA.—(*Fournier*.)

ERYTHEMATOUS SYPHILODERM.

- (1) Usually apyretic.
- (2) No itching.
- (3) Lasts several weeks at least.
- (4) Preceded a short time by the symptoms of syphilitic infection, chancre, glandular involvement, etc.
- (5) Accompanied by other syphilitic manifestations, crusts in the scalp, enlargement of the cervical glands, evening headache, lesions of the mucous membranes, etc.

SIMPLE ERYTHEMA.

- (1) Often accompanied by feverish symptoms, loss of appetite, coated tongue, thirst, malaise, and headache.
- (2) Very frequently more or less itching.
- (3) Ephemeral.
- (4) No previous symptoms of syphilitic infection.
- (5) Not accompanied by secondary syphilitic symptoms.

DIFFERENTIAL DIAGNOSIS BETWEEN THE ERYTHEMATOUS SYPHILODERM AND DERMATITIS FROM COPAIBA.—(*Fournier*.)

ERYTHEMATOUS SYPHILODERM.

- (1) Eruption not pruritic.
- (2) Eruption rose-colored, without a vinous tint.
- (3) Eruption without special points of concentration.
- (4) Eruption persistent at least for some weeks.
- (5) Eruption follows the symptoms of syphilitic infection without any drug having been taken.

DERMATITIS FROM COPAIBA.

- (1) Eruption sometimes itches slightly, at other times quite severely.
- (2) Eruption deeper in color, having more of a wine tint than the syphilitic manifestation.
- (3) Eruption shows a tendency to confluence at certain points, such as the extensor surfaces of the joints.
- (4) Eruption ephemeral, disappearing in a few days when the drug has been discontinued.
- (5) Eruption follows a special cause, recent ingestion of copaiba.

The *evolution* of the erythematous syphiloderm is slow. Unlike the febrile exanthematic eruptions, which reach their full development in from twenty-four to forty-eight hours, it first shows itself by a patch of eruption here and there; more patches follow, and day by day new lesions succeed, the eruption taking a week or more to unfold itself completely. Once fully developed, it remains unchanged for a considerable period. Under the influence of treatment it fades rapidly, but left alone it may persist for weeks or months, becoming darker and partially pigmented, while new forms of syphiloderm may meanwhile make their appearance. At this period the eruption is no longer

an erythematous, but a polymorphous, syphiloderm—erythematous in one place, papular or pustular in another. It is usually in this last aspect that the eruption shows itself in practice. The erythematous syphiloderm, pure and simple, is not by any means as frequently encountered as this mixed eruption made up of various lesions.

Finally, the erythematous eruption disappears, the pigmentation is gradually absorbed, and the skin shows no trace of the former disease.

The erythematous syphiloderm may recur, in which case it shows itself under a somewhat different aspect, the lesions being larger, fewer in number (sometimes only a dozen in all), more scattered, and of a rather paler tint. When mercury has been given, the erythematous syphiloderm rarely recurs, and when it does so it is only after a long interval. When this form of the erythematous syphiloderm is found upon a patient, the disease may be regarded as of old date.

PAPULAR SYPHILODERM.¹

The papular syphiloderm is characterized by the appearance of small, hard, solid elevations of various size, not containing fluid, and of a coppery or ham-red color, terminating in resolution. It assumes various forms, and may be best described under the following heads: (a) small papular syphiloderm; (b) large papular syphiloderm; (c) papulo-squamous syphiloderm; (d) moist papular syphiloderm (mucous papule); (e) vegetating syphiloderm.

SMALL PAPULAR SYPHILODERM.—This consists of an eruption of single and disseminate, or grouped and more or less confluent, pin-head or small pea-sized, distinctly elevated, hard, rounded, or pointed papules. They give the impression of roughness when the hand is passed over the surface of the skin. The summit of the papules may be smooth or covered with fine scales. The eruption is apt to be complicated by the occurrence of miliary pustules.² It is at first of a bright-red color, but subsequently assumes a dusky tint. It is a well-marked eruption, usually occupying a considerable area, and is most frequently seen about the shoulders, arms, trunk, and thighs.

The small papular syphiloderm may occur either as one of the first general manifestations of syphilis, as early as the third or fourth month after infection, or it may not show itself until later, after other lesions have occurred. It is apt to be chronic in its course, and often resists treatment with some stubbornness. Relapses are not infrequent. Other lesions are apt to be present concomitantly, notably large flat papules, moist papules, and small pustules, as mentioned above. The affections for which it may be mistaken are *keratosis pilaris*, especially when the papules are numerous and scattered, pierced by a hair, and in the colored race, and *psoriasis punctata*. Occasionally it is confounded with *eczema*, but the pruriginous character of the last-mentioned affection, its history, and the absence of concomitant syphilitic symptoms, should prevent the occurrence of such a mistake.

LARGE PAPULAR SYPHILODERM.—This is composed, as its name indicates, of lesions larger than those just described, the papules varying from one-half to three centimetres in diameter, being usually roundish in outline, raised above the general surface of the skin, and flat. To the touch they are firm and

¹ See R. W. Taylor, Observations on the Papular Syphilides (Am. Jour. Syph. and Derm., April, 1870); and On a Peculiarity of the Papular Syphilide in the Negro (Ibid., April, 1873).

² See an excellent representation of the papular syphiloderm, accompanied by miliary pustules, in Duhring's Atlas of Diseases of the Skin, Plate i.

circumscribed. In their early stage they are commonly smooth and free from scales. They are usually ham-colored, although occasionally light or very deep red in tint. While often present in considerable numbers, the lesions are not as numerous as in the small papular variety. The lesions may be found scattered over different parts of the body, or collected in one locality in groups or patches. The forehead (*corona veneris* of older writers), region of the mouth, nape of the neck, back,¹ flexor surfaces of the extremities, scrotum (Plate XIX. Fig. 1), labia, perineum, and margin of the anus, are the localities where this eruption is ordinarily encountered.

The large papular syphiloderm is one of the commonest skin manifestations of syphilis. It may occur early or late in the course of the disease, or it may occur as a relapse. Commonly it follows closely on, or accompanies, the erythematous eruption. The lesions appear in divers localities and of different sizes in the course of a few weeks, and are met with in various stages of growth. Once formed they remain for some time—weeks or months. The large flat papular syphiloderm yields more readily to treatment than the small variety. Where the lesions occur in certain localities, their appearance and character may become considerably modified. About the mouth or anus, and occasionally upon the hands and feet, deep fissures sometimes form, giving rise to great annoyance and pain.

THE MOIST PAPULE.²—A common transformation of the large flat papular syphiloderm is into the moist papule. Moist papules may occur either upon the general surface of the skin, or upon the muco-cutaneous tissues about the mouth, vulva, anus, etc. The lesion as it occurs upon the skin, begins by a red spot which soon assumes the form of a papule, more or less elevated above the general surface, its borders higher than the somewhat depressed centre, the latter covered with a thin crust under which, on raising it, the moist surface of the lesion can be seen. When the evolution of the lesion goes on to a cure, the crust falls off leaving a thin epidermic scale beneath, and it finally disappears without a subsequent scar. Sometimes a copious eruption of the large flat papular syphiloderm may take on this character, and the lesions may assume the appearance of moist papules. A not very uncommon occurrence is the transformation, *in situ*, of the chancre into a moist papule. As the initial lesion is about to disappear, it suddenly springs into new life again; induration recommences, the lesion becomes larger and more elevated above the surrounding skin, its surface becomes moist, begins to secrete, and, becoming crusted or not according to location, is often distinguished with difficulty from surrounding lesions of an apparently similar character, the lesions of the generalized eruption.

Moist papules of the muco-cutaneous integument are closely analogous to those occurring on the skin generally. In some cases, this form of the moist papule assumes the character of a smooth papular elevation of regular contour, slightly darker in color than the surrounding mucous membrane, with a moist surface secreting an abundance of muco-pus of a characteristic and disgusting odor. This variety is rarely isolated, but is usually accompanied by other moist papules, and also by a papular eruption upon the skin. Its commonest seat in man is about the glans, and on the scrotum (Plate XIX. Fig. 1). In women it is most commonly met with on the external genitals, in both

¹ See Duhring's Atlas, Plate AA.

² This form of the syphilitic papule is often known by the name of "mucous patch," but I prefer to restrict that designation to the lesions, which may or may not be papular in character, occurring on the mucous membranes only. The two varieties of the disease run into one condition on the muco-cutaneous surfaces, but are essentially distinct when met with in their typical form. (See Syphilis of the Mucous Membranes.)

I.



2.



Mucous patches of mouth and tongue.

Mucous patches of scrotum and buttocks.

sexes about the anus, and in the infant about the umbilicus. This variety of the moist papule is most liable to hypertrophy and the formation of vegetations, of which mention will be made hereafter.

A second variety of the moist papule occurring on the muco-cutaneous surfaces, consists in a superficial ulceration without a true papular formation, denuding the epithelium merely, and looking like a superficial desquamation or denudation rather than the serious lesion which, in fact, it is. This variety is commonly met with in women, upon the vulva, and is occasionally observed to become more indurated and take on a papular character, or to ulcerate, or finally to become covered with a diphtheritic membrane.

Moist papules when seated upon the commissures of the lips, between the roots of the fingers, etc., often assume the form of fissures. On the vulva they are, when numerous, not infrequently accompanied by a sort of firm œdema which persists even after they have been cured. When moist papules secrete abundantly, they often give rise to severe itching, and now and then even to inflammatory reaction with pain.¹

VEGETATING PAPULES.—Instead of being flat, the moist papule may take on hypertrophic action resulting in the formation of luxuriant warty or papillary growths, when the lesions are entitled *vegetating papules*. The lesions assume an elevated, more or less circumscribed, warty character, resembling the raspberry or cauliflower formation. Between the papillary growths there may be slight ulceration accompanied with offensive secretion, which, drying, forms yellowish or brownish crusts. This condition is most prone to occur on the face, scalp, about the shoulders, and near the genitals (Duhring). It is on no account to be confounded with the acuminate or "venereal" wart, which will be described in the following Article.

The secretion of the vegetating syphiloderm is contagious; not that it produces vegetations in others than its bearer, but that it carries the syphilitic contagion. The secretion of the vegetating papule will, in other words, produce a chancre when inoculated upon a healthy person.

Although not auto-inoculable, yet the lesions are usually found grouped, and often multiply greatly in the regions favorable to their growth, that is, in those localities where heat and moisture are present with the irritating secretions of other lesions. Want of cleanliness is an important factor in the causation of these lesions. They are usually amenable to local and hygienic treatment employed in addition to the ordinary constitutional measures. (See Local Treatment of Syphilis.)

THE PAPULO-SQUAMOUS SYPHILODERM.²—The ordinary papular syphiloderm frequently takes on a scaly character, presenting certain peculiarities which require its separate description. It presents different appearances as it occurs in one locality or another, and according to the arrangement of the lesions. These may be scattered and isolated, or they may be grouped or joined together in diffused patches. They are generally flattened, and are covered with a dry, grayish, adherent scale. This is usually scanty as compared with the scales in psoriasis, which this form of the syphiloderm otherwise closely resembles. If the scales are removed, the papules beneath are seen to be

¹ For a table showing the comparative frequency of these lesions, see page 508.

² This is the affection formerly and very erroneously called "syphilitic psoriasis," a term which used to give rise to much confusion. While the etiology of psoriasis is still unknown, it is quite certain that it is not due to syphilis. The question has been thoroughly discussed and settled by Duhring (Differential Diagnosis between Psoriasis and Syphiloderma Squamosum, Phila. Med. Times, vol. iv., 1873-4; and So-called Psoriasis Syphilitica, *ibid.*), and the term syphilitic psoriasis is no longer used by dermatologists.

elevated or flattened, of a dull red color, and more or less sharply defined. The eruption is rarely extensive, and is not infrequently composed of a few scattered lesions at wide distances apart.

The *palmar and plantar syphiloderm* is a variety of the papulo-squamous affection, which is modified by the peculiar structure of the skin in the affected parts. The palms and soles are favorite localities, and here the eruption is apt to prove very persistent. The lesions sometimes look more like macules than papules; they are slightly raised above the surrounding skin, as a rule, ill-defined, and from split-pea to finger-nail sized. Sometimes they coalesce into crescentic or serpiginous and irregular patches. The lesions are usually covered with a thin scale, more abundant about the edge, giving the appearance of a *collarette* (Plate XX. Figs. 1 and 2). If these scales are removed, the surface beneath is seen of a dull red color. Sometimes, especially upon the sole, an abundant formation of epidermis takes place, giving the patch a horny appearance (as seen in some of the lesions depicted in Plate XX). At other times the lesions take the form of large pin-head or small pea-sized epithelial concretions, which can be dug out of the skin like the so-called "roots" of corns. This is the *syphilide cornée* of French writers, and when it occurs extensively on the soles, it may prevent locomotion. I recently saw a case where the plantar eruption was extensive, and where the patient described the feeling on walking as if the shoes were filled with hard peas. Occasionally the lesions display no desquamation, but have simply a dull-red erythematous look. In addition to the lesions described, fissures often exist extending deeply into the corium.

The eruption is usually, though by no means always, symmetrical, and is apt to appear upon the centre of the palm or sole, or upon the ball of the thumb or the hollow of the foot. It rarely attacks the backs of the hands or feet, and is usually strictly confined to the palm or sole. Now and then, however, a large patch is found to creep up over the edge of the palm or sole to the skin beyond, the disease commonly extending by a distinctly elevated, crescentic border.

As regards the extent of the eruption, this varies greatly in different cases. Sometimes a single small lesion on one palm or sole may alone exist. In other cases it may be much more extensive, both palms and both soles being covered with the eruption. As a rule, there is neither heat nor itching. The affection is very chronic and persistent; it may last for years, and is often extremely rebellious to treatment. It may be either an early or a late syphilitic manifestation. When it occurs symmetrically, it is usually in the earlier stages; but single, isolated and unilateral eruptions are more commonly of late occurrence, sometimes years after the initial lesion.

The *diagnosis* of the papulo-squamous syphiloderm often presents considerable difficulties, and its various characteristic features should be studied with great care in all doubtful cases.¹ It is liable to be confounded with *eczema*, with *psoriasis*, and on the palm or sole with *callosity*. From *eczema* it may be distinguished by the absence of heat, itching, and discharge, the two former of which symptoms are almost always present in *eczema*. The course of the eruption and its history will also often be of assistance in the diagnosis.

In the examination of cases, when the diagnosis lies between the papulo-squamous syphiloderm and *psoriasis*, the following facts should be borne in

¹ See an excellent paper by Bulkley, On the Diagnosis and Treatment of Chronic Scaly Eruptions of the Palm of the Hand. New York Med. Record, March 18, 1876.



Syphiloderma of palm and sole.

mind. The syphiloderm is almost invariably confined to adult age, and is the result of acquired syphilis; psoriasis frequently manifests itself in early life, before the age of twenty. The history will almost always give some account of antecedent syphilitic symptoms, or, on the other hand, of previous psoriasis. The edges of the patch of syphiloderm are generally elevated, and possess a well-defined line of demarcation, the disease terminating abruptly against the healthy skin. When the scales are removed from a patch of psoriasis, it is seen to be scarcely elevated above the level of the surrounding skin, and not infrequently melts imperceptibly into it. The syphiloderm is not usually symmetrical, while psoriasis is very commonly so. Both syphilis and psoriasis may invade the palms and soles alone, but when psoriasis is encountered in these parts it is apt to be met with on other parts of the body also, particularly on the extensor surfaces of the elbows and knees. Itching is apt to be present in psoriasis; it is rarely present in the syphiloderm, and, when it does exist, is but slight. Psoriasis may extend rapidly; the syphiloderm extends very slowly. The difference in the pathological structure of the lesions is a great help in diagnosis. The syphiloderm being a deeper infiltration and deposit in the skin, gives the appearance of thickness in the tissue of the skin, while in psoriasis the lesions are much more superficial. In psoriasis the epidermic involvement, shown by scaliness, is most obvious; in the syphiloderm it is the base of the lesion which is seen to be the prominent and essential manifestation. The syphiloderm is very apt to be polymorphous, particularly if widespread—some lesions may almost always be found which are characteristic; in psoriasis, on the other hand, the type is preserved in all the lesions wherever they show themselves. Finally, some of the syphilitic lesions are liable to break down, and at one time or another give rise to some sort of ulceration, discharge, and crusting, while psoriasis is a dry disease, always and at all times.

The following table, from Fournier, will give some further information regarding this question of diagnosis:—

DIFFERENTIAL DIAGNOSIS BETWEEN THE PAPULO-SQUAMOUS SYPHILODERM AND PSORIASIS.

PAPULO-SQUAMOUS SYPHILODERM.

(1) Surface of the papule almost always incompletely covered with scales; denuded over a greater or less area. Sometimes simply a *collerette* of scales around the papule.

(2) Scales thin, small, transparent, superficial, and of a grayish color.

(3) The eruption is of a dark red, sometimes coppery or ham color.

(4) The skin in the immediate neighborhood of the lesion is rather resistant to the touch than thickened, sometimes resembling the parchment-induration of chancre.

(5) Individual lesions generally small or of medium size; often roundish, circular, or of a contour made up of segments of circles.

(6) No characteristic localization except one form, the palmar and plantar.

PSORIASIS.

(1) Surface of the lesion always covered with scales, sometimes quite thickly.

(2) Scales large, thick, superposed, imbricated, often forming a thick covering, a sort of epidermic shell over the lesion; the individual scales white and pearly.

(3) Color less distinctly red and less deep in tint when the scales are removed.

(4) Skin thickened rather than resistant to the touch in the immediate neighborhood of the lesions.

(5) Lesions sometimes small, but also frequently large, forming patches of considerable size; presenting to a much less degree a rounded outline.

(6) Characteristic localization, extensor surfaces of elbows and knees.

PAPULO-SQUAMOUS SYPHILODERM.

(7) Duration relatively short compared with that of psoriasis.

(8) The lesions rapidly disappear under the influence of mercury.

(9) Antecedent or even concomitant syphilitic manifestations.

PSORIASIS.

(7) Duration always long. Frequently a history of persistence since childhood or early youth.

(8) The lesions remain uninfluenced by mercury.

(9) Antecedent or concomitant syphilitic symptoms only accidental. Frequently a history of arthritic rheumatism.

VESICULAR SYPHILODERM.¹

Vesicles are rarely encountered in syphilis, the lesions which commonly show themselves as such in their early stages becoming eventually transformed into pustules. The lesions in typical cases vary in size, form, arrangement, and distribution. They may be small, pin-head sized, more or less acuminate, and disseminated or grouped; or split-pea sized, flat or semi-globular, with or without umbilication. The small miliary vesicles manifest themselves as irregularly grouped or disseminated lesions, inclining to involve the hair follicles, and are succeeded by minute, yellowish, granular crusts. Sometimes the larger vesicles assume a varicella-like appearance and distribution, the lesions being split-pea sized and slightly umbilicated, containing a clear or cloudy fluid, and being surrounded by a reddish areola. They are apt to be peculiarly persistent, lasting for days without undergoing change.

The eruption commonly shows itself in localities where the skin is naturally thin, as upon the face and genitalia. It is rarely extensive, nor are its lesions numerous. Its course is usually rapid, the lesions terminating in rupture and slight crusting. Other lesions, especially papules, coexist. The eruption is early, occurring within the first six months or year of the disease.

Occasionally syphilitic eruptions are met with closely resembling eczema. The following abstract of a case, which I reported several years ago,² is of interest, because the eruption resembled eczema in so many respects that, without a history and without the concomitant lesions to guide one, a mistake in diagnosis might readily have been made, and, in fact, was made at first, in spite of these aids.

The patient, a woman of forty, in the seventh year of an attack of syphilis characterized by successive outbreaks of various kinds, presented an affection of the scalp consisting of a hand-sized patch of infiltrated, red, scaly, and crusted disease, pouring out a profuse serous secretion, thick, tenacious, clear, and yellowish in color, which matted the hairs together, and even ran down over the neck. On pulling the hairs apart, or lifting the dried crusts of serum and epidermis, the surface of the skin could be seen, red, raw, and weeping. There was little or no odor from the scalp. The patient complained of some pain in the head, and of severe itching. The affection was mistaken at first for eczema, and treated locally. The patient disappeared for many months, and when she returned again presented unequivocal symptoms of syphilis in connection with the same vesicular eruption, which healed finally under specific treatment.

THE PUSTULAR SYPHILODERM.

The pustular syphilodermata, although not as common as the erythematous and papular eruptions, constitute a large and important group. They

¹ The best description of this affection may be found in Bassereau (*Affections de la Peau symptomatiques de la Syphilis*), and in Hardy (*Leçons sur la Scrofule et les Scrofulides et sur la Syphilis et les Syphilides*).

² *Archives of Dermatology*, 1876, p. 217.

appear in a variety of forms, the lesions of which differ in size, shape, number, distribution, and other features.

The pustules vary greatly in size, shape, and form. They may be pin-head or finger-nail sized, circular, ovalish, or irregular, acuminated, rounded, or flat. They may be situated on indurated papular bases, or surrounded by an extensive areola, in which case they are but little elevated above the level of the surface. They may be few or numerous, and are apt to be disseminated over the surface without regularity of distribution. From the decided inclination to crust which the larger pustules manifest early in their course, they have been termed "pustulo-crustaceous lesions." The crusts usually begin to form shortly after the lesions manifest themselves, but sometimes they form simultaneously with the pustules. As a rule, the larger the pustule, the sooner will the process of crusting begin.

The crusts vary in color from yellow to brown, or even black, and when of any size and depth incline to assume an olive-greenish hue. Beneath the recent crust there always exists an ulcer. This may be superficial or deep, according to the general character of the primary lesion. The edges are usually sharply defined, giving the lesion a punched-out appearance. The fact of this ulcerative condition existing only in the lesions of syphilis, should be borne in mind when endeavoring to make a diagnosis in doubtful cases. If a doubtful crust is lifted with a pin or other instrument, and an excoriated surface only is found beneath, the chances are in favor of the presence of a non-syphilitic lesion. But if, on lifting the crust, an ulcer is seen with its base covered with an abundant, grayish, yellowish, or greenish, puriform secretion, the lesion is in all probability syphilitic. The pustular lesions are followed by pigmentation, and usually by cicatrices. They may occur early or late in the disease. When early, they are of more serious significance.

THE SMALL ACUMINATED PUSTULAR SYPHILODERM (*Miliary Syphiloderm*).—In this variety of the pustular syphiloderm the pustules are millet-seed sized, raised above the level of the skin, and seated upon minute, reddish, papular elevations, and contain a very small quantity of purulent fluid. When they dry, small yellowish crusts fall off, leaving a slight desquamative exfoliation in the form of a ring, the "collerette" of the French. The hair follicles are commonly involved, the hairs penetrating through the centres of the lesions.

The eruption is usually abundant, the pustules existing in great numbers, discretely or confluent, and irregularly disseminated in groups over various lesions. Sometimes they are arranged in circles or segments of circles. When the eruption appears for the first time it generally covers a large surface, but occurring as a relapse it may be localized. The arms, thighs, chest, and back are favorite localities. Various stages of the eruption, together with large and small papules, and sometimes miliary vesicles, are observed in connection with the lesions under consideration. The miliary pustular syphiloderm may be one of the earliest skin manifestations of syphilis, occurring six weeks after the initial lesion, and accompanied with fever and other general symptoms; or it may be seen as a later though still early manifestation. Relapses may occur, and the lesions as they disappear leave deep pigment stains and pitted depressions which are slowly effaced. The diagnosis is not difficult. The eruption does not usually occur alone, but is generally accompanied by other symptoms of syphilis.¹

LARGE ACUMINATED PUSTULAR SYPHILODERM.—This is the *acneiform syphiloderm* of some writers, and is characterized by the appearance of pointed

¹ See Duhring's Atlas, Pl. L.

pustules, looking not unlike those of acne and smallpox. The crusts which result from drying up of the pustules are yellowish or brownish-yellow, and are seated upon small superficial ulcers. The eruption may break out rapidly, with fever, or it may develop slowly. In the first case, small red macules appear, which rapidly develop into papules and then pustules, the eruption reaching its full development in from twenty-four to forty-eight hours. In the subacute form papules slowly appear, and upon their summits a small quantity of pus gradually accumulates. In the acute form the lesions are numerous and widely disseminated. In the subacute form the lesions are less numerous, and are more apt to be localized and grouped. They are met with on the scalp, face,¹ and trunk; more rarely upon the extremities. Other syphilitic lesions, such as papules, are apt to be present.

This eruption is one of the earliest of the pustular syphilodermata, and, as a rule, pursues a rapid and benign course. It is apt to be mistaken for *acne* and especially for *smallpox*. The history, however, will easily prevent any mistake being made regarding acne. When fever is present, it is sometimes a little difficult to distinguish between the acneiform syphiloderm and the eruption of variola. The various concomitant symptoms must be carefully inquired into. In the syphilitic eruption, the initial lesion, or some trace of it, can often be found, and glandular engorgement in the groins, and in the epitrochlear and cervical regions, should usually be present. In addition, the well-known polymorphism of syphilis should lead to the careful scanning of the entire cutaneous surface, with the view of finding moist or dry papules, or other unquestionably syphilitic skin lesions, concomitant with the manifestation under investigation. The acneiform syphiloderm is also liable to be confounded with the eruptions produced by the ingestion of iodide or bromide of potassium. The pustules of these medicinal eruptions, however, contain cheesy or sebaceous contents quite different from the frankly purulent fluid of the syphiloderm, and the history of the case also assists in the diagnosis.

Sometimes, however, an exact diagnosis of acneiform syphiloderm is difficult, if not impossible, at sight and off-hand, and a few days must be allowed to elapse in order to determine the nature of a questionable eruption.

THE SMALL FLAT PUSTULAR SYPHILODERM.—This eruption, sometimes called the *impetiginiform syphiloderm*, is made up of small, flat pustules, grouped into an irregularly shaped patch. Crusting begins almost immediately, rendering the lesions markedly pustulo-crustaceous. The crusts are thick, bulky, and more or less adherent; they are of a yellowish-green, or yellowish-brown color, and sometimes coalesce and form a sheet. The ulcer underneath the crust may be superficial or deep.

The eruption is usually met with upon the face, especially about the nose and mouth—on the hairy parts of the face—on the scalp, and about the genitalia. It is generally benign, but may sometimes take on a malignant form with deep ulceration. The impetiginiform syphiloderm may be mistaken for *impetigo* or for *pustular eczema*—the latter especially upon the scalp. On raising the crusts of the syphilitic lesions, ulcers will be found beneath. These are never encountered in eczema, an excoriation alone being seen when the crust is detached in this disease.

THE LARGE FLAT PUSTULAR SYPHILODERM (*Ecthymatiform Syphiloderm*).—The lesions here are large, finger-nail sized, flat pustules, seated upon a deep red base. They incline to dry up and crust immediately. There are two varieties, the superficial and the deep. The first shows a flat, yellowish-

¹ See Duhring's Atlas, Pl. v.

brown crust, on a superficial ulcer or erosion. The lesions are numerous, and are usually seated on the back, shoulders, and extremities, though they may occur elsewhere.¹ It generally occurs between the sixth and the twelfth month of the disease, and runs a benign course.

The deep variety possesses a larger, more raised, and bulky crust, sometimes conical, and stratified like an oyster-shell—whence the name *rupia*, which is applied to this lesion as well as to the crusted form of the bullous syphiloderm. Beneath the crust the ulcer is seen to be excavated, deep, punched out, and covered with an unhealthy-looking, greenish-yellow, puriform secretion. The lesions are less numerous than in the first variety, sometimes only three or four being present at any one time. It is a late and usually a malignant manifestation.

TUBERCULAR SYPHILODERM.

The eruption here consists of one or more solid elevations of the skin, varying in size from a split pea to a hazelnut; smooth, glistening, rounded or somewhat pointed, hard, and felt to be deeply seated. Their color varies from a brownish ham color, to a bright red or true copper color. Sometimes they have an intensely smoky-red hue, a color not met with in any other disease of the skin.

They may occur singly or grouped together, but rarely in great numbers. They are apt to be confined to some single region of the body. When in large numbers they are apt to form tubercular patches. They may be irregularly grouped, or arranged in segments of circles.

SERPIGINOUS FORM.—Sometimes a serpiginous tract is thus formed, the eruption being then known as the *serpiginous tubercular syphiloderm*, apt to be a very obstinate form of the disease.²

The tubercular syphiloderm is indolent, unaccompanied by any subjective symptoms, and occupying weeks and months in its development. It is a late manifestation, rarely showing itself before the second year, and generally not until later. Not infrequently it does not appear until five, ten, or even twenty years after the initial lesion, and in women, in whom the early symptoms of syphilis are sometimes entirely overlooked or ignored, the diagnosis is occasionally difficult. I have repeatedly met with cases where a single tubercle, the size of a split pea, situated perhaps in the angle of the ala nasi,³ and resembling to all but the experienced eye a lesion of acne, was the only representative of syphilis. In such cases it is vain to attempt to extract a history. No one is likely to remember the slight “ulcerated sore throat,” “fever blisters,” or “heat rash,” which may have attracted passing attention a dozen years previously. Yet the recognition of some small tubercular lesion will occasionally, perhaps, give the clue to obscure nervous symptoms which might otherwise go unexplained, and perhaps be erroneously treated.

The lesions of the tubercular syphiloderm disappear in one of two ways—by absorption or ulceration. They may ulcerate superficially or deeply, usually the latter, the ulcer being deeply punched-out, horse-shoe shaped, or crescentic, and covered with a grayish-yellow deposit of gummy matter, or with a brownish crust. Ulceration may also attack a patch of grouped

¹ See Dühring's Atlas, Plate v.

² See R. W. Taylor on the Serpiginous Tubercular Syphilide. Am. Jour. Syph. and Derm., Jan. 1870.

³ The illustration in Plate XIII. Fig. 1, gives the characteristics of this lesion in a typical and well-marked case. I refer in the text to the possible occurrence of a single one of such nodules.

tubercles, the result being an extensive excavation, involving at times the whole affected surface. Not infrequently the process assumes a serpiginous course, the ulceration being usually accompanied by a certain amount of simultaneous cicatrization, and it is then apt to be disfiguring in its results. It is often encountered on the back, and is generally obstinate. (Plate XXI.)

VEGETATING FORM.—Papillary formations at times spring up from the surface of ulcerating syphilitic tubercles, forming wart-like and cauliflower excrescences, accompanied by a yellowish, puriform, offensive secretion—the *syphilis cutanea papillomatosa*. Many cases of the so-called frambæsia of older writers were aggravated instances of this variety of disease. The same form of growth may occur with the gummatous ulcer.

The tubercular syphiloderm is to be diagnosed from lupus vulgaris, from lepra, and from carcinoma. It is most liable to be confounded with lupus vulgaris. The tubercles of syphilis, however, are firmer, more deeply seated, and have a history of more rapid development. Lupus, moreover, appears usually first in childhood, while the tubercular syphiloderm is rarely seen before adult or middle age.

THE GUMMATOUS SYPHILODERM.

Gummata of the integument are usually situated primarily in the subcutaneous connective tissue, and only subsequently make their appearance in the true skin. But although denied by some writers, yet true gummatous infiltration of the skin does unquestionably occur, and in a form which is easily to be distinguished clinically from the tubercular syphiloderm, with which it is most apt to be confounded.

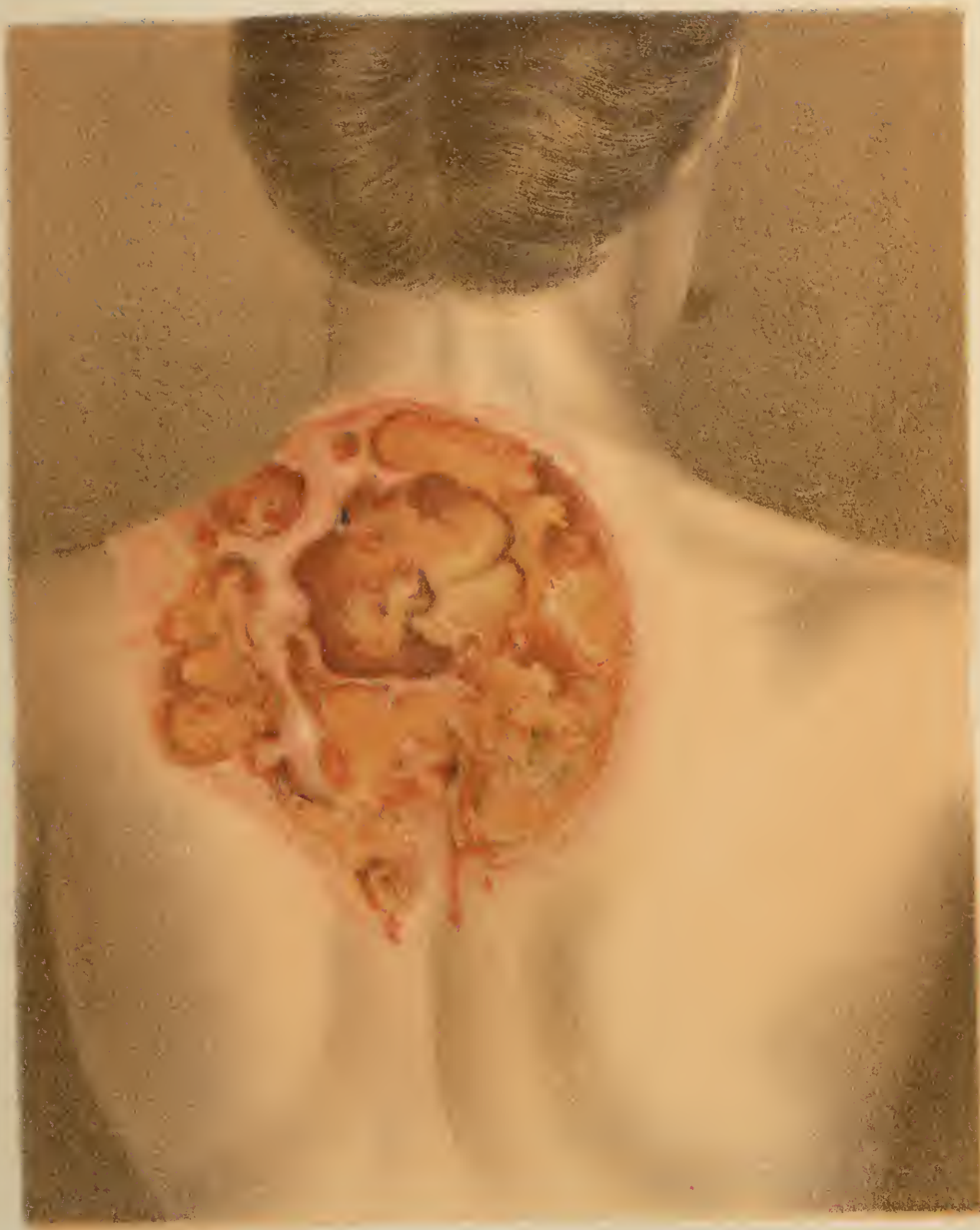
The gumma of the skin appears first as a more or less circumscribed formation, in the form of a slightly raised, rounded, or flat tumor, variable as to

Fig. 334.



Gumma of the nose.

size, and tending to break down into an ulcer. More commonly, however, it begins in the subcutaneous connective tissue, and is felt as a small-pea sized, ill-defined, painless body, which is felt to be beneath the skin. The latter is



Tubercular ulcerating syphiloderma.

Late lesions of Syphilis.



not altered in color, nor is the outline of the growth discernible. The deposit increases slowly in volume, until through a period of weeks or months it gradually assumes definite shape and consistence. It is now seen to be a more or less rounded tumor, imbedded in the subcutaneous tissues, the skin over which becomes pinkish or reddish. In size it may vary from that of a hazelnut to that of a walnut, or even larger, with a slightly elevated semi-globular shape, and with a soft, doughy, somewhat elastic feel.

Gummata are usually solitary, rarely occurring more than one or two at a time. They may occur in any part of the body, but are most commonly met with in the looser and softer tissues, as upon the flexor surface of the extremities, the abdomen, the sides of the thorax, the penis, etc. (Plate XXII. Fig. 3.)

The gumma tends strongly to break down and ulcerate, with destruction of the tissues in which it has its seat. The ulcer is a circumscribed, deep excavation, usually rounded in form, with abrupt, perpendicular edges. It may vary from the size of a finger-nail to that of the hand. Its bottom is uneven, and covered with a grayish-red gummy deposit. The loss of tissue is usually great, but the process of repair leaves often a much less marked cicatrix than would have been predicted. Gummata are occasionally absorbed without ulceration.

The diagnosis of the gumma is usually not difficult. It is to be distinguished from furuncle and from abscess, from enlarged lymphatic glands, from carcinoma, and from fibrous and fatty growths. I think the gumma is more apt to be confounded with abscess than with any other affection. I have often seen gummata which have been mistakenly poulticed until they have broken down into ulcers. This is an unfortunate mistake, as the early administration of iodide of potassium will often put back and cause absorption of the syphiloma, thus shortening the duration of the affection, and in many cases preventing the subsequent formation of a scar. The history of the case, the freedom from pain and febrile reaction in a lesion which to the eye presents the appearance of marked and decided inflammation, as well as the history of its slow and usually painless evolution, will serve to stamp the suspected furuncle or abscess as in reality a gumma.

The gummatous ulcer will be diagnosed from the non-syphilitic ulcer by its history, depth, sharply defined edges, and punched-out appearance;¹ by the character of the secretion; the absence, as a rule, of pain, excepting in gummatous ulcers of the leg, when pain is often present; and the presence, in many cases, of other symptoms of syphilis.

THE BULLOUS SYPHILODERM.

The bullous syphiloderm² is characterized by blebs containing a clear, watery fluid, which tends soon to become cloudy and thick. At times, indeed, the lesions are more like pustules than blebs. In size they vary from that of a pea to that of a walnut. They are discrete, disseminated, circular or ovalish in form, and surrounded with a slight areola. They may be fully or only partially distended, but after lasting a variable time they break, the contents drying into yellowish, brownish, or dark greenish crusts. These sometimes assume a heaped-up, oyster shell-like appearance which gives rise to the name *rupia*, applied to this eruption as well as the large flat pustular syphiloderm above described. Beneath the crusts are seen erosions or shallow ulcers, which in

¹ This characteristic is shown in Pl. XXII., Fig. 3.

² Formerly, to the confusion of the student, called "syphilitic pemphigus."

healing leave more or less pigmented cicatrices. The course of the eruption is variable, depending upon the condition of the patient's general health.

The bullous syphiloderm is a late eruption, and usually occurs in connection with other syphilitic manifestations. It is rare, and is met with in cachectic, broken-down subjects. It often occurs as the result of hereditary syphilis in the new-born, when it closely resembles pemphigus vulgaris.¹ The character of the blebs, and of the subsequent crusts, will, however, easily serve to distinguish this syphiloderm from pemphigus.

THE PIGMENTARY SYPHILODERM.

This eruption, the existence of which has been denied by some observers, is very rare. It has been described (with a chromo-lithographic illustration) in the second edition of Fournier's "*Leçons sur la Syphilis*," and in this country by G. H. Fox² and by J. E. Atkinson.³ It consists in a more or less circumscribed pigmentation of the skin, in the form of roundish, ovalish, or irregularly shaped, split-pea or finger-nail sized, discrete or confluent macules, on a level with the skin. They are not preceded by hyperemia, nor do they follow upon the site of other syphilitic lesions. Their color is a pale, yellowish-brown, often so faint as to cause them to present rather the appearance of dirt marks than of lesions in the skin. They are apt to coalesce and form a sort of net-work. There are no subjective symptoms. The affection occurs in the latter half of the first and in the second year of syphilis. Its course is slow, and it is uninfluenced by specific treatment.

LOCAL TREATMENT OF THE SYPHILODERMATA.

The general and internal treatment of the syphilodermata is that of syphilis in general, and for this reference may be made to the section on treatment. The local management of these lesions demands, however, some special notice here.

The erythematous syphiloderm does not require local treatment, nor will this, unless in the form of the mercurial vapor-bath, be apt to do much service. The papular syphiloderm likewise does not often require the aid of local applications, excepting when the surface of the lesions is denuded, as in the moist papule, or where they occupy a conspicuous position, as on the face. For the moist papules occurring about the anus or genitalia, especially when accompanied by vegetations, extreme cleanliness, separation of the adjoining parts with dry lint or cloths, and thorough washing with dilute solution of chlorinated soda, may be employed. In connection with these measures, the moist surface of the lesions may be dressed with finely powdered calomel, or anointed with the following ointment:—

R.—Pulv. hydrarg. chlor. mit. ℥ss.
Ung. aquæ rosæ, ℥j. M.

The same ointment, well rubbed in, hastens the disappearance of papular lesions on the face.

Great relief may be obtained in the case of pustular eruptions by the early

¹ See under hereditary infantile syphilis.

² Am. Jour. Med. Sci., April, 1876.

³ The Pigmentary Syphiloderm, a paper read before the American Dermatological Association, at its second annual meeting, 1879, and published in the Chicago Med. Jour. and Exam., Oct. 1879.

removal of the crusts when these begin to form, and by dressing the eroded or ulcerated surfaces with some mildly stimulating ointment, such as that just given, or with the following:—

R.—Hydrarg. ammoniat. ℥j.
Ung. aquæ rosæ, ℥j. M.

Of course, when the lesions are numerous, local applications are made with difficulty to every part, and must then be confined to such lesions as, from their situation, give rise to much discomfort. In case of the more discrete and widely scattered pustular eruptions, a warm bath, taken when the crusts are ready to become detached, will loosen them entirely, and then the eroded surface of the lesions may be lightly anointed with some very mild stimulating ointment, such as this:—

R.—Zinci oxidi, ℥ss.
Adipis, ℥iiss.
Sevi, ℥v.
Ol. rosæ, ℥ij. M.

The mercurial ointments should not be employed over large surfaces, or on numerous lesions, for fear of absorption.

In the ulcerating tubercular or serpiginous tubercular syphiloderm, I know of no application as useful as iodoform in one shape or another. Dusted lightly on the surface of the ulcer and covered with a piece of raw cotton, its good effect is often really surprising. Lesions will often heal up under iodoform with marvellous rapidity. A good iodoform ointment is this:—

R.—Pulv. iodoformi,
Bals. Peruv. āā ℥ss.
Adipis, ℥iv. M.

But the penetrating and disgusting odor of iodoform is a serious bar to its employment, and more commonly we must make use of other remedies. Among these, the most generally useful is the black wash of the U. S. Pharmacopœia, and, in some cases, the yellow wash. These two washes are also useful, particularly the yellow wash, in the treatment of gummatous ulcers. Occasionally these ulcers, as they occur upon the lower extremities, are irritated, inflamed, and painful; under which circumstances rest and soothing applications, such as lead-water cloths or poultices, must be applied first, before the more stimulating applications are brought into play.

LESIONS OF THE APPENDAGES OF THE SKIN.

ONYXIS.¹—Syphilitic affections of the nails may assume several different forms, some of a comparatively trifling character, others much more troublesome. Occasionally a comparatively ephemeral affection occurs on the nails, chiefly of the fingers and most commonly met with in women, where the nail becomes dry, friable, and fissured, the free portion showing transverse ridges, and the nail breaking and splitting with the least pressure or violence. This is an early manifestation, and it may persist through a considerable period (*onyxis craquelée*, friable onychia).

Another form occasionally met with is *hypertrophic onyxis*. The nail may assume three or four times its normal thickness, its color changes to a dull

¹ See Emanuel Kohn, Remarks upon the Pathology and Therapeutics of Syphilitic Diseases of the Nails. (Wien.med. Presse, Nos. 24, 27, und 28, 1870.) Translated in Am. Journ. Syph. and Derm., vol. ii., 1871, p. 78.

grayish or yellowish tint, it is covered with rough transverse or longitudinal ridges, and its free border may be bent and horn-like, or it may be thickened and squared off with a rough laminated edge. One or more nails may be affected. Commonly this affection runs a course *pari-passu* with the other early, generalized symptoms, the diseased nail tissue being gradually replaced by healthier structure as the general system recovers its tone under the influence of constitutional treatment. Now and then it runs a slower course, and, being stubborn to both general and local treatment, persists for months after other symptoms have disappeared.

A third form of onychia is that in which, the matrix being involved, a part or the whole of the nail is detached from its bed, and is gradually separated and shed. Not infrequently the nail is first separated at its root, and is then carried gradually forward, leaving the rough and hardened matrix imperfectly covered with a corneous growth behind. Regeneration gradually takes place, and in time, with the improvement of the general health under treatment, a healthy nail takes the place of the diseased one.

None of the affections of the nails above described are painful, and they are important chiefly on account of the deformity to which they give rise, and as indicative of the general state of the system.

PERIONYXIS.—When a syphilitic papule is developed in the cutaneous fold bordering the nail, the hypertrophied epidermis becomes fissured and more or less horny, and exfoliates, forming a sort of dry, squamous perionyxia which is painless, and which, although extremely persistent, gives no trouble unless picked and irritated by the patient, when it may develop ulceration. Another form of perionyxia begins by a peri-ungual swelling like an ordinary “run-around;” the extremity of the member becomes more or less enlarged, and of a dull currant or coppery color. The process, which is a sub-inflammatory one, goes on slowly and without pain, in this respect differing from the acute, painful course of the “run-around.” It never terminates in an abscess, usually ending in resolution, but sometimes ulcerates superficially, forming ulcerative perionyxia.

Ulcerative perionyxia is characterized by a loss of substance of variable extent and degree, affecting the border, sides, or free extremity of the nail, or pulp of the member. The ulcer has an unhealthy aspect, being covered with sanious sanguinolent pus, and the swollen tissues in the neighborhood are dusky and more or less livid. This form of perionyxia when occurring in the toes is easily confounded with ingrowing toe-nail, but the extent of the swelling, its indolent character, and the extension of the ulceration serve to mark the syphilitic character of the lesion. The perionyxia may be complicated by onychia, the nail separating entirely or in part, and the member becoming greatly enlarged, and covered with ulcerating and fungous granulations. After a considerable period, reparation takes place, with the entire or partial restitution of the nail, which is rarely normal in appearance; or, when the matrix has been nearly destroyed, a rough, hard, knobby surface remains in place of the normal nail.

The treatment of the dry form of onychia and of perionyxia is the general treatment of the early stage of syphilis. The inflammatory form is best treated by occlusion with the *Emplastrum de Vigo*,¹ and by use of the ordinary

¹ The *Emplastrum de Vigo*, formerly extensively employed, is composed of lead plaster, 2 lbs. 8 oz.; yellow wax and resin, each 2 oz.; ammoniac, bdellium, olibanum, and myrrh, each 5 dr.; saffron, 3 dr.; mercury, 12 oz.; turpentine, 2 oz.; liquid storax, 6 oz.; oil of lavender, 2 dr. The gum, resin, and saffron to be powdered, the mercury to be rubbed with the storax and turpentine in an iron mortar until completely extinguished. The plaster then to be melted with the wax and resin, and the powders and volatile oil added to the mixture. When the plaster has

antiphlogistics. When the ulceration is once established it is exceedingly difficult to obtain a cure. Jullien says it is "one of the most embarrassing problems of therapeutics," and my own experience entirely confirms this opinion. Among the remedies most likely to give a satisfactory result may be mentioned the twenty per cent. solution of nitrate of silver (argenti nitrat. gr. c, aquæ f3j). Small pledgets of lint soaked in this solution are inserted into the ulcerated cavities (Diday). Fournier recommends powdered iodoform, and Vanzetti of Padua powdered nitrate of lead. Camphor and alum is another topical application which has been suggested. Bumstead and Taylor advise the use of strong solutions of caustic potassa (3j-iv to f3j) to repress the profuse granulations of the matrix. They also suggest prolonged immersion of the member in very warm water containing powdered borax (3ij-Oj), to diminish the swelling and remove the secretions. Gradual pressure, carefully applied, may sometimes be advantageously used, and soothing ointments, such as that of belladonna, or Goulard's cerate, may be required in inflammatory cases. The most assiduous cleanliness is required, and the various applications named, as well as others which may suggest themselves, should be essayed in turn when the case is rebellious.¹

ALOPECIA.—Falling of the hair may occur, without any special lesion of the integument, as a result of perverted nutrition caused by the syphilitic poison. The hair becomes dull, tarnished, and dry-looking, and the patient, as Diday says, looks as if he wore a wig. The least effort brings out the hair "by the handful." A very common seat of alopecia of this variety is the eyebrow, a segment of which is often denuded completely of hair. This alopecia of the eyebrow is regarded by Fournier as pathognomonic of syphilis, even when met with alone. Sometimes general alopecia occurs, involving not only the scalp, but the eyebrows, eyelashes, beard, pubes, etc. But even when the scalp has become almost bald under the influence of the syphilitic disease,² complete restitution of its normal covering may be hoped for if the general condition improves under the influence of specific treatment, and the same is the case with this form of alopecia occurring elsewhere. In spite of the current notion, more prevalent, however, in Europe, where the popular knowledge of syphilis is more general if not more accurate, than in America, that premature baldness is due to syphilis, this is not at all the case. Syphilitic alopecia, of the form just described, is the most curable variety of the affection.

Another form of syphilitic alopecia is that caused by syphilitic eruptions of the scalp. Acneiform or pustular lesions of this region are not uncommon, even in the earlier periods of the disease, so that one of the commonest ques-

cooled, but while still liquid, the mercurial mixture to be thoroughly incorporated. This is now superseded for general use by the emplastrum ammoniaci cum hydrargyro of the U. S. Pharmacopœia. The mixture of diachylon with mercurial ointment is, in Bumstead and Taylor's opinion, smoother and more efficient than either the ordinary mercurial plaster or the Emplastrum de Vigo.

¹ See Victor de Méric, Syphilitic Affections of the Nails (Brit. Med. Journ., 1865, p. 45); Betz, Treatment of Syphilitic Perionyxis by Occlusion (Giorn. Ital. delle Mal. Ven., 1868, t. ii. p. 180); Delattre, Treatment of Onyxis (Giorn. Ital. delle Mal. Ven., 1868, t. ii. p. 370); Em. Kohn, Zur Pathologie und Therapie der syphilitischer Nagelerkrankungen (Wien. med. Presse, 1870, xi., 24, 27, 28); Diday, Traitement du Perionyxis Ulcéreux (Annales de Dermatologie et de Syph., 1871, t. iii. p. 182); Fournier, De l'Alopécie, de l'Onyxis et du Perionyxis comme accidents de la Période Secondaire de la Syphilis (Annales de Dermatologie et de Syph., 1871, t. iii. p. 12); Bergh, Syphilitic Affections of the Nails (Hosp. Tidend., 1880, vii., Nos. 46, 47. Abstract in Archives of Dermatology, vol. vii., 1881, p. 336); Hutchinson, Diseases of the Nails (Med. Times and Gaz., April 20, 1878).

² Fournier tells of a patient who, at one period of his alopecia, could boast of but seventeen hairs upon his entire head.

tions asked of a patient from whom it is desired to elicit a history of syphilis is, "have you ever had crusts or scabs on the scalp, or falling of the hair?" Papular and pustular eruptions may indeed give rise to alopecia, but this variety, like the first mentioned, is only temporary, the hairs being renewed when the lesions are cured, excepting in those cases of pustular eruptions where the hair follicles may have been destroyed.

A third variety of alopecia occurring in the course of syphilis is that met with late in the disease, when ulceration of the scalp has occurred with destruction of the follicles. This variety is, of course, irremediable.

Syphilitic alopecia requires nothing more than the usual constitutional remedies in order to cure it completely; nevertheless, for the purpose of quieting the patient's mind, and also, perhaps, to hasten a return to the normal condition, certain topical applications may be employed with advantage.¹ The following is a good tonic hair wash:—

R.—Tinct. cantharidis, f3v.
Tinct. capsici, f3ij.
Ol. ricini, f3v.
Aq. cologniensis, ad f3iv.—M.

In some cases this pomade may be more conveniently employed.

R.—Medullæ bovis, 3ss.
Tinct. cantharidis, mxx.
Hydrarg. chlor. corros. gr. ss.
Ol. rosæ, mjj.—M.

SYPHILIS OF THE MUCOUS MEMBRANES.²

The term *mucous patch* is sometimes used indiscriminately to designate both syphilitic lesions, other than ulcers, occurring on mucous membranes, and also moist papules of the cutaneous or muco-cutaneous surface. Although there is a strong similarity in many respects between certain syphilitic lesions of the external integument and those of the mucous membranes, yet for convenience's sake I have chosen to consider them under distinct heads, giving the name *moist papule* to the lesion of the general integument (see description of the Large Papular Syphiloderm), and reserving the name *mucous patch* for the lesion as found upon the mucous membranes.

THE SEAT OF MOIST PAPULES AND MUCOUS PATCHES.

The statistics of Davasse and Deville³ show that in 186 women these lesions were seated:—

Upon the vulva in	174 cases.
About the anus	59 "
On the perineum	40 "
On the buttocks and the inner and upper aspect of the thighs	38 "
On the tonsils	19 "
On the nose	8 "
On the tongue	6 "
About the toes	5 "

¹ For further information, see: Dulaurier, *Alopécie; guérison par les Préparations Mercurielles* (Gaz. des Hôp., 1864, p. 310); Donet, *Syphilis Constitutionnelle; Alopécie* (Gaz. des Hôp., 1864, p. 259); Fournier, *De l'Alopécie, de l'Onyxis et du Perionyxis comme accidents de la Période Secondaire de la Syphilis* (Annales de Dermatologie et de Syph., t. iii., 1871, p. 12). See, also, Fournier, *Leçons, etc.*, 2e éd., p. 347.

² For further description of the various lesions of the mucous membranes, especially the later ones, see *Syphilis of the Digestive Tube, etc.*

³ Des Plaques Muqueuses. Archives Gén. de Méd., 1845.

Bassereau's statistics show that in 130 men these lesions were observed:—

About the anus in	110 cases
On the tonsils	100 "
On the scrotum	66 "
On the mouth and lips	55 "
On the glans and internal surface of the prepuce	28 "
On the velum palati	27 "
On the tongue	18 "
On the half arches	17 "
On the internal aspect of the cheeks and lips	11 "
In the interdigital spaces of the feet	11 "

The mucous patch, like its counterpart, the moist papule, is one of the most important lesions in the entire series of syphilitic manifestations, not only because of its extremely contagious character, but also because of the frequency of its occurrence. Many persons who contract syphilis escape the severer skin eruptions, and the grave, late manifestations, but scarcely any, if, indeed, any at all, escape mucous patches in some shape, or at some period of the early development of the disease. Indeed, as Jullien remarks, the history of an average case of syphilis may be summarized as follows: a chancre, a transitory erythematous rash, and, following this, *mucous patches, relapses of mucous patches, more mucous patches!*

Mucous patches occur and recur without regard to other manifestations, which may come and go, be present or absent, without influencing the course of the mucous lesions. The secretion of the mucous patch is, as has been said, in a high degree contagious. Next to chancre, the mucous patch is the commonest source of infection.¹

The most frequent seat of mucous patches in men is within the mouth, while in women these lesions are more commonly found upon the vulva. Their development within the mouth is favored by the use of tobacco, either by smoking or chewing, while in all regions uncleanness is both an inciting cause and a means of keeping the lesions in existence. Mucous patches within the genital organs of both sexes sometimes give rise to a discharge from the neighboring mucous membrane, resembling gonorrhœa, which is not infrequently observed about the time that early secondary symptoms appear, or when a relapse of general symptoms takes place.²

Mucous patches within the buccal cavity present the appearance of grayish-white, irregular patches, not elevated, or sometimes depressed below the surface, looking as though they had been pencilled over with nitrate of silver (whence the name "opaline patches," by which they are sometimes known). The most common seat of these lesions is upon the internal surface of the lips and cheeks (Plate XIX. Fig. 2), upon the tongue (Plate XIX. Fig. 3), upon the gums, tonsils, and soft palate. They sometimes extend beyond the pillars of the fauces, and are seen upon the walls of the pharynx and the posterior nares. They have also been seen upon the epiglottis and mucous membrane of the larynx.³

When mucous patches occur near the angle of the mouth, they often extend into the muco-cutaneous structures at the commissure of the lips, where they form cracks and fissures which possess the characteristic pearly-gray color of these lesions, and where they are often continuous with a patch of the small flat papular or pustular syphiloderm. On the dorsum of the tongue their base is sometimes hard, indurated, and fissured; or the pellicle which covers them

¹ See above under Sources of Syphilitic Contagion.

² Bumstead and Taylor.

³ Ibid.

may be rubbed off by the attrition of the food, when a slightly depressed, smooth, red surface remains. Vegetations may occasionally form in this locality, as in the case of moist papules on the integument. These, in my experience, are much more rebellious to local treatment than the ordinary mucous patches occurring in this locality. Mucous patches upon the tonsils are peculiarly exposed to irritation, and are often very difficult to heal. Sometimes they develop into ulcers, attended by considerable inflammation and swelling of the surrounding parts, which may at times obscure the original lesion and render it difficult of diagnosis. Deglutition may be considerably impeded, and the swelling may close the Eustachian tube and produce more or less complete, temporary deafness. The neighboring lymphatic glands are sometimes sympathetically enlarged when the mucous patches are inflamed.

The earliest appearance of mucous patches is on the twentieth day after contagion; the usual period for the first appearance of the lesions is from one to two months after contagion, although they may not appear for five or six months after this period. The early administration of mercury delays the appearance of mucous patches sometimes to eighteen months. Their reappearance at a later period in the history of the disease is one of the most certain signs of the renewed activity of the virus.

Treatment.—Mucous patches invariably demand local as well as general treatment. When they occur within the female genitalia, astringent and detergent injections, such as the decoction of oak-bark or Labarraque's solution, are useful. Pencilling with nitrate of silver may also be required. For mucous patches of the mouth, pencilling with nitrate of silver, in stick or solution, should be frequently practised, and the following mouth-wash may be employed:—

Powdered chlorate of potassium, ʒj.

“Eau de Botot,” fʒiv.

Use a teaspoonful in a wineglass of water, as a gargle, four or five times daily.

It is hardly necessary to add that the most scrupulous attention to cleanliness is demanded, and, in case of mucous patches of the mouth, the use of tobacco must be strictly forbidden. The tobacco-chewer, in particular, is apt to keep his mucous patches indefinitely. I always insist upon the abandonment of this mode of using tobacco, and decline to treat the case without a pledge that my directions in this matter will be complied with.

SYPHILIS OF THE CELLULAR TISSUE; GUMMATOUS TUMORS.

Something has already been said about the gummata in dealing with the syphilitic affections of the skin, and some further remarks on the nature of these tumors will be made further on when describing the various lesions of the viscera. It may be repeated now, however, that the chief seat of the gumma is in the connective tissue wherever found.

The name gumma is given to those small tumors which contain at one period or another of their existence a thick gummy fluid. They are among the later lesions of syphilis. Their appearance differs somewhat, according to the region attacked. At the outset, gummata of the subcutaneous connective tissue present themselves in the form of grouped or isolated tumors of small size, rolling under the finger, roundish, hard, and completely indolent. After a time they lose their mobility, and become adherent to the superjacent skin, which in its turn gradually becomes involved. The tumor now softens in the centre, and the skin covering it begins to change, becomes red in color,

softens, and is finally perforated. The gumma may remain in a fluctuating condition for some time without opening. When it does open, if this is early, the escaping fluid is clear, viscid, and gummy. If the tumor does not open for a long time, the fluid discharged is more apt to be sanious and fetid, or purulent. The opening is smaller than the cavity of the abscess formed, and the bottom of the tumor retains its firmness and induration—at times an important point in diagnosis.¹

The ulcer succeeding the gummatous tumor is roundish, excavated, and surrounded by a dusky red areola. When a number of tumors have been grouped together or agglomerated, the resulting ulcers may unite, forming a large and very irregular sore, with numerous perforations, the openings of deeper gummata. The floor of the gummatous ulcer is generally covered with a peculiar, whitish, putrid layer of débris of characteristic appearance.

When a gumma heals, it leaves behind a roundish, hollowed, white cicatrix, surrounded by an areola of pigment, which gradually disappears.

In addition to these general characteristics of gummata, they possess special peculiarities dependent upon the locality in which they occur, and which will be noted in describing the lesions of the various organs. Occasionally the growth of gummata may cause pressure upon some important part, and thus arouse functional disturbance.

Gummata are not infrequently accompanied by other syphilitic manifestations, such as the severer syphilodermata; and not infrequently by lesions of the bones and viscera—exostoses, syphilitic sarcocele, etc.

The commonest localities for the occurrence of gummata are the face and scalp, the external surface of the limbs, the posterior portion of the shoulder, the attachment of the sterno-mastoid to the sternum, various parts of the mouth, the isthmus of the fauces, and, among the viscera, the testicles and the mammae.

Though sometimes single, gummata are more frequently found in groups. They may indeed be very numerous, more than 150 lesions having been counted on a single patient.

The gumma is, as has been said, a late lesion, never occurring previous to the sixth month, and sometimes not for years after the initial lesion. Cases have been reported where the first recognized symptom of hereditary syphilis has been the appearance of a gumma thirty years after the patient's birth.

The course of the gumma is naturally very slow; it may remain stationary for months, at any period of its development. No other syphilitic lesion is so rapidly influenced and modified by treatment.

DIAGNOSIS.—The diagnosis of gummata sometimes offers considerable difficulty, especially when the tumors are deeply seated; treatment is in doubtful cases often the only touchstone, and will decide the question with certainty. When the gumma is situated in the subcutaneous cellular tissue, or in the submucous cellular tissue of the buccal cavity or upper part of the pharynx, the objective signs usually suffice to establish the diagnosis. When concomitant syphilitic symptoms are present, it is easy to make out the character of the lesion. When these are absent, and above all when the gumma is solitary, some difficulty may be met with. The not yet softened gumma may be recognized by its rounded form, its firmness, its invariably moderate size, and its indolence. The seat of the tumor, its mobility, and the absence of ganglionic involvement, must also be taken into account. While these characteristics are met with in other than syphilitic tumors, they are rarely so well marked.

¹ See illustration of gumma of the penis, Pl. XXII., Fig. 3.

Gumma of the mamma may be mistaken for adenoid tumor. The symptoms and course of the two forms of tumor are much the same, and it is difficult to distinguish between them. The touchstone of treatment here comes into play, and will decide the question. Much as I dislike this resource of weakness in syphilitic cases, yet I know not how else, oftentimes, the diagnosis can be settled. It is far different in the syphilitic skin manifestations. To fly to mercury and iodine for the purpose of settling the nature of a doubtful skin disease, is to take the ready refuge of ignorance and incompetency.

It is oftentimes difficult to distinguish between gummata of certain regions—as the tongue, isthmus of the fauces, and penis—and cancer of those parts. When suppuration has once begun, the gumma is unlikely to be mistaken for any other affection excepting chronic abscess, and particularly scrofulous abscess. The scrofulous abscess, however, has not as long a period of incubation as the gumma, and, when it breaks down, suppuration takes place at all points, the resulting ulcer having everted edges rather than the undermined edge of the gummatus ulcer. The age of the patient and the seat of the affection also bear upon the diagnosis.

The gummatus ulcer is distinguished from the scrofulous ulcer, for which it is most likely to be mistaken, by the fact that the latter shows itself chiefly upon the face and neck in young subjects. Its edges are everted and violaceous; the pus which bathes its surface is gummy and caseous, and the cicatrix which succeeds the ulcer is prominent and keloid-like. In addition, the concomitant enlargement of the lymphatic glands in the case of scrofula, and the general appearance, are to be borne in mind.

PROGNOSIS.—The prognosis of gumma is always grave, for its presence signifies the tenacity and persistency of the syphilitic virus in the system. It is often accompanied indeed with more or less marked debility.

TREATMENT.—Iodide of potassium is the great remedy against gummata. It should be given in large doses, often even to the amount of a drachm or a drachm and a half daily. When the constitution is debilitated, tonics, such as cod-liver oil, iron, and quinine, should be given freely, as well as nourishing food, and, in properly-selected cases, stimulants. *A gumma which has not opened should never be poulticed or cut into, even when fluctuation has set in.* This is a golden rule, unfortunately too often broken by practitioners who fail to make a correct diagnosis, and who fancy that they have to deal with some sort of an abscess, or by surgeons who cannot resist the impulse to drive a bistoury into any fluctuating tumor which may present itself. Gummatus tumors can often be resolved, even at the last moment and when fluctuation can be distinctly felt, under proper treatment.

When a gummatus abscess has actually formed, various local applications may be employed. Tincture of iodine, pure or mixed with water, black wash or yellow wash, or one of the mercurial ointments, may be employed. Now and then the detergent influence of chlorinated soda may be brought into action.

It may be said, finally, that now and then the iodide of potassium treatment, which is successful in the vast majority of cases, fails. In this case, mercury can be joined to it or used alone. Sometimes an entire suspension of antisyphilitic treatment for a time seems to do good.

SYPHILIS OF THE ALIMENTARY TRACT.

MOUTH.—The mouth is almost invariably the seat of some syphilitic lesion, at one time or another in the course of the disease, and various lesions may occur in this locality, from the most superficial to the most profound.

Chancre, as has been stated, may occur about the mouth, being most commonly met with upon the lower lip, and being also encountered upon the tongue or tonsils, and, more rarely, upon the internal surface of the cheek, the gums, or the uvula.

Under the name of *acute syphilitic angina*, an erythematous efflorescence has been described, which occurs simultaneously with the earliest generalized manifestations of syphilis, appearing upon the palate, tonsils, and pharynx, as a diffuse redness with slight infiltration of the mucous membrane, and followed by the occasional formation of minute follicular abscesses. Associated with this condition there is often a general œdema, especially of the velum and uvula. The uvula is sometimes greatly swollen, but neither under such circumstances, nor even when it has become considerably eroded by later ulcerative lesions, should it be removed, since nature carries out a better system of repair spontaneously. Acute syphilitic angina cannot be distinguished from simple sore throat, except by the aid of the history or concomitant symptoms of the disease.¹

Mucous patches, and the slighter ulcerative lesions of the mucous membrane of the buccal cavity, have been described under the head of lesions of the mucous membranes.² It may be noted in passing that mucous patches are not found upon the walls of the pharynx, a curious fact which is explained by the theory that as these lesions chiefly affect the papillary layer of the mucous membrane, the absence or ill-development of papillæ in the pharynx accounts for their absence in that locality. The subjective symptoms to which mucous patches of the mouth give rise are almost *nil*, causing the patient oftentimes to be unaware of their presence. When, however, ulceration takes place, particularly about the tonsils, this may be quite extensive even when only superficial in character; it may give rise to great discomfort, and, when situated about the tonsils, to considerable difficulty in deglutition.

The deeper syphilitic ulcers which are met with in the bucco-pharyngeal cavity occur either spontaneously, or as following and resulting from gummata, submucous tubercles, or osseous lesions. These ulcers are indolent, with a sharply defined, punched-out appearance, and with a dull, dusky base covered with grayish deposit. They are commonly limited in extent and do not tend to spread, but occasionally they take on phagedænic action and effect the most frightful ravages. A case has been reported where one of these ulcers penetrated to the lingual artery, requiring ligation of the primitive carotid to save life. Necrosis of the underlying bone occurs, at times, when the ulcer is situated in the pharynx or over the hard palate, communication sometimes being established between the nose and mouth, in the latter case, by this means.

Treatment.—The local treatment of the more superficial syphilitic lesions of the buccal mucous membrane is essentially that described under the head of syphilis of the mucous membranes. Something more, however, may be here added. The two customary caustics employed are nitrate of silver, either in stick or in solution, and acid nitrate of mercury. The second is preferable,

¹ See Martelliére, De l'Angine Syphilitique. Thèse de Paris, 1854.

² See, also, Kaposi, Die Syphilis der Haut und der angrenzenden Schleimhäute. Wien, 1881. Neue (unveränderte) Ausgabe.

not only because less superficial and more thorough than the nitrate of silver, but because it does not leave a black stain as the silver application does. The latter is a matter of some moment to patients who may have a visible lesion, as a mucous patch of the commissure of the lips. Nitrate of mercury has one fault, however—it gives rise to pain and swelling; but these can be avoided by due caution in its application.

Caustics should not be applied to the bucco-pharyngeal mucous membrane without due precautions. The affected surface should first be dried, as otherwise the caustic will flow in all directions. Solutions should never be applied by means of a glass rod. A case of death has been reported, occurring from spasm of the larynx induced by a drop of nitrate-of-silver solution let fall during cauterization of the pharynx. The solid stick is less dangerous. Though not to be recommended for use in the pharynx, yet if employed, only a short piece should be used, as of course the quantity swallowed in case of accident would be less. For caustic solutions, a bit of soft pine wood, or a carefully moistened camel's hair pencil, is the best applicator.

The deeper lesions, when not phagedænic, are best treated by cleanliness and dependence upon internal treatment, iodide of potassium having peculiar efficacy in these cases. When a disposition to phagedænic action shows itself, caustics may be employed in addition, but the internal treatment must also be strongly pushed.

TONGUE.—The *tongue* is the seat of various syphilitic lesions which in this locality present certain peculiarities worthy of notice. In the earlier stages of the disease, an erythematous rash is sometimes though rarely encountered, showing itself in the form of a group of roundish red patches surrounded by a border of desquamating epithelium. A form of syphilitic papule is another rare lesion, which, however, is occasionally met with upon the tongue. It assumes the appearance of a slight elevation, covered with dull epithelium which gives it a whitish color. The mucous patch is a very common syphilitic lesion of the tongue. In one variety it usually occupies the median portion of the dorsal surface, in the form of an erosion, a smooth, red, rounded patch deprived of its papillæ, and of a polished aspect. In a more advanced stage of evolution this erosive patch is papular and mammillated, owing to hypertrophy of the papillary layer of the derm. Its color is still bright red, and its surface smooth and polished; it may grow to the size of a cherry or almond pit, disfiguring the surface of the tongue.

Syphilitic patches on the tongue may be distinguished from somewhat similar lesions, as follows:—

Chancre.—Solitary lesion; induration; edges of a frankly inflammatory red color; deep ulceration, the bottom often covered with false membrane, and, at a later period, with exuberant granulations; submaxillary adenitis.

Aphthæ.—Slight ulcers, with irregular borders, without induration, often covered with denuded epithelium on which a yellowish lactescent fluid can be observed; lesion rarely isolated; usually painful when ulcerated.

Ultero-membranous Stomatitis.—A rare affection, particularly upon the tongue; coincidence of ulceration on the gums, the internal surface of the cheeks, and the lips; fungous and pultaceous condition of the base of the ulcer, swelling of adjacent parts; frequent localization on one side of the mouth; frequent and considerable development of painful ganglia corresponding to the lesion.

Another variety of lesion, not infrequently found upon the tongue, is that known by the barbarous name of "buccal psoriasis."¹ It is more apt to be found on the side of the tongue. In its earlier stages, this variety of the

¹ This name is given to non-syphilitic lesions of the tongue as well. It is confusing, and should be abandoned.

mucous patch may give rise to considerable swelling and œdema, while at a later period it assumes a hard, gristly appearance, and becomes exceedingly intractable to treatment, sometimes lasting a very long time without change.¹

The later syphilitic lesions of the tongue are of two distinct varieties, called by Fournier² *sclerous glossitis* and *gummatous glossitis*. Both varieties are much commoner among men than among women. They generally make their appearance between the fifth and the twelfth year of the syphilitic disease, although now and then they may appear as early as the second, or as late as the fifteenth or even the twentieth year. They usually affect the dorsal surface of the tongue.

Sclerous glossitis may be either superficial, characterized by induration in small or large patches, involving only the upper layer of the mucous membrane, and having a sombre red tint, with a smooth depapillated surface; or it may be deep ("lingual sclerosis," "lobulated glossitis"), characterized by cellular hyperplasia extending to the parenchyma of the tongue, and characterized by tumefaction, mammilation and lobulation of the dorsal surface of the organ, deep induration of the affected parts, with fissuring, together with various alterations of the mucous membrane covering them.

Gummatous glossitis occurs in two varieties, according as the mucous membrane or the submucous and muscular tissues of the tongue are attacked. The former of these begins in the form of pin-head or pea-sized indurations, situated superficially in the mucous membrane of the tongue, hardly perceptible to the sight, but firm to the touch. After a time these little nodules slowly break down and form ulcers, which are peculiarly deep and sharply cut, as if with a small punch. The deep or muscular gumma of the tongue is chiefly distinguished from the former variety by its size (from pea to almond, or even date size), and by the fact that it clearly involves the muscular tissues of the tongue. When it breaks down it leaves a large, deep, well-marked ulcer, usually on the dorsum of the tongue.

The diagnosis of late syphilitic glossitis of whatever kind does not usually offer any great difficulties. Chancre, "psoriasis buccalis," or "lingualis," smokers' glossitis, dental glossitis, and tuberculous glossitis, can usually be distinguished without much difficulty. With cancer of the tongue, however, some difficulty may arise. The history, if carefully obtained, will in this case be of considerable value.

The following Table is given by Fournier to show the differential diagnosis between ulcerative cancer and ulcerative gumma of the tongue :—

ULCERATIVE CANCER OF THE TONGUE.	ULCERATIVE GUMMA OF THE TONGUE.
1. Affection of mature age, maximum frequency between 50 and 70 years.	1. May occur at any age after puberty. Generally observed at an earlier age than cancer.
2. Predisposing cause, hereditary tendency. No syphilitic antecedents excepting by chance.	2. Syphilitic antecedents. No antecedent cancer excepting by chance.
3. Frequent antecedents of "lingual psoriasis."	3. No antecedents of "lingual psoriasis."

¹ A representation of this lesion is given in Plate X. Fig 3. See also Debove, *Psoriasis Buccal*, Thèse de Paris, 1873; and Mauriac, *Du Psoriasis de la Langue et de la Muqueuse Buccale*, Paris, 1875, for a fuller description of these lesions, especially from a diagnostic point of view.

² *Des Glossites Tertiaires. Avec trois planches en chromolithographie.* Paris, 1877. An excellent monograph.

³ The deep form of sclerous glossitis is represented in Plate XIII. Fig. 3.

ULCERATIVE CANCER OF THE TONGUE.

4. Begins by the appearance of a hard superficial nodule, an *external* tumor; then more or less rapid ulceration of the surface. No opening or evacuation as of an abscess at the beginning of the ulcer; no excavation.

5. Lesion always *single* and *unilateral*, with rare exceptions.

6. May occupy the inferior aspect of the tongue.

7. Lesion made up of a tumor, the superficial portion of which is ulcerated.

8. Edges in relief, forming a raised border, irregular, everted, notched, etc.

9. Surface bleeding easily at the slightest touch.

10. Secretion abundant, becoming in the advanced stage fetid and ichorous.

11. The ulcer spontaneously painful, lancinating. Occasionally radiating pains towards the ear.

12. Functional troubles always marked and sometimes extreme; immobilization of the tongue; difficulty of speech, of mastication, of deglutition; salivation, etc.

13. Lesion leading gradually, after a given time, to general symptoms of cachexia.

14. Anatomical examination reveals the characters of epithelioma.

15. Ganglia affected after a certain period.

16. Anti-syphilitic treatment is without benefit, or even injurious.

ULCERATIVE GUMMA OF THE TONGUE.

4. Begins by a hard *internal* nodule; then sudden opening as of an abscess; a cavern at first, then rapid ulceration, displaying the mammillated bottom of the tumor.

5. Lesion sometimes *multiple* and *bilateral*.

6. Is localized exclusively upon the superior surface and edge of the tongue; never affects the lower surface.

7. Lesion made up of an ulceration without a true tumor, in the proper acceptance of the word.

8. Excavated, sharply-cut edges, smooth and defined.

9. Bottom irregular and not bleeding.

10. Secretion relatively scanty and not ichorous.

11. Ulcer not spontaneously painful, not lancinating.

12. Functional disturbances very much less marked than in cancer. Tongue not immobilized as in cancer—at least not to the same degree.

13. The lesion itself does not give rise to cachexia.

14. Anatomical examination reveals the characters of degenerated gummatous hyperplasia.

15. Ganglia intact.

16. Anti-syphilitic treatment produces a beneficial effect.

Treatment.—The treatment of the more superficial and early forms of syphilis of the tongue is that of early syphilis in general, mercury holding the most important place. The later affections, and in particular deep sclerous glossitis and gummatous glossitis, require iodide of potassium for their successful management. Local treatment is important. It comprises cleanliness and various topical applications. In the case of the superficial lesions, astringent gargles containing chlorate of potassium (as mentioned under the head of mucous patches), together with stimulating applications, as of the nitrate-of-silver stick lightly touched upon the part, will be found most satisfactory. But for the later lesions these must be laid aside: chlorate of potassium, alum, borax, etc., are here all useless, as are also mercurial gargles, which, indeed, are sometimes positively harmful. Mucilaginous washes are most soothing and grateful. Decoction of marsh-mallow—not gargled hastily, but allowed to remain in the mouth at least five minutes, and repeated twenty or thirty times a day—will be found to give much relief to the patient, and to hasten the cure. Emollient douches of marsh-mallow decoction serve to keep the surface clean and pure in the ulcerative forms of the disease, and the atomization of warm emollient decoctions, and, in

rebellious cases, of a solution of iodide of potassium, ten grains to the ounce, is attended with the happiest results.

Cauterization must be employed in the sclerosed variety with precaution, and not, as is too frequently done, promiscuously. The fissures and raw surfaces may be cauterized, but not the sclerosed surfaces. The nitrate-of-silver stick is the best application; acid nitrate of mercury and the stronger caustics often aggravate instead of relieving the condition. Cauterization should not be repeated too frequently—once a week is often enough. In the gummatous form of glossitis, cauterization is only demanded to hasten the process of repair when this has once set in. A light application of tincture of iodine about the border of the ulcer, once or twice a day, or a slight pencilling with the crayon of nitrate of silver to stimulate forming granulations, is all that is required.¹

PHARYNX.—Lesions of the pharynx, though not among the commoner lesions of the mucous membranes, are not rare. Mucous patches, as has been observed, are not found in this locality, but ulcerating submucous tubercles, gummata, and bone lesions, are not infrequently met with. The ordinary or serpiginous ulcers of the pharynx are commonly met with in the posterior wall, and resemble the same lesions as observed in the hard palate.² Gummata of the pharynx are among the late lesions, and are usually situated on the posterior wall, the lesion showing itself first in the form of a small subcutaneous nodule, which increases in size very gradually, pushing forward the mucous membrane under which it lies, and which becomes discolored. After a greater or less period of time has elapsed, the tumor softens and ulcerates, or, if proper treatment has been employed in time, resolution may take place without a scar. Gummata of the pharynx may be mistaken for cancer.

Maisonneuve³ gives the case of a patient who underwent a serious operation for a supposed encephaloid cancer of the pharynx. After six months the tumor began to grow again, and grew so rapidly that the patient was given up in despair and sent to the hospital to die. When examined, upon his entrance, an enormous tumor was found occupying the left lateral region of the neck and the entire parotid region. It projected into the pharynx, obliterated the velum palati, and threatened the patient with death by asphyxia. The true nature of the tumor being suspected, the patient was at once placed upon iodide of potassium in sixteen-grain doses thrice daily. In *less than six weeks* the tumor had disappeared without leaving a vestige!

Carcinoma, in fact, is the affection with which gumma of the pharynx is most apt to be confounded. It should be remembered, in making the diagnosis, that the cancerous tumor (it is epithelioma which is here understood) is not as sharply circumscribed as the gumma, that it is less movable in the surrounding tissues, and, contrary to what is observed in gumma, is usually accompanied by some change in the neighboring lymphatic ganglia. Retropharyngeal abscess is distinguished from gumma, when acute, by the inflammatory concomitant symptoms, and when subacute and cold, by the very early appearance of fluctuation.

The *prognosis* of syphilitic affections of the pharynx is grave when any important function is involved, when a large gumma in suppurating gives rise to purulent infection, or when irregular contractile cicatrices are formed,

¹ For further information see various monographs by Bouisson, *Gaz. Méd. de Paris*, 1846; Lagneau, *Des Tumeurs Syphilitiques de la Langue*, *Gaz. Hebdom.*, 1859, Nos. 32, 33 et 35, and *Arch. Gén. de Méd.*, t. i., 1860, p. 217; and Maisonneuve, *Sur les Tumeurs de la Langue*. Thèse de Concours. Paris, 1848.

² See Wigglesworth, *Buccal Ulcerations of Constitutional Origin*. A paper read before the American Dermatological Association, at the fifth annual meeting, Newport, 1881. *Archives of Dermatology*, January, 1882.

³ *Leçons Cliniques sur les Maladies Cancéreuses*. Paris, 1854.

which may, in some cases, interfere with phonation or audition. Late affections of the pharynx are very apt to be present, or to have existed, in cases of cerebral syphilis.

The *treatment* of syphilis of the pharynx is, in the first place, that of the constitutional affection; then, the local applications described under the heading of lesions of the mouth, and, in addition to these, the use of medicated vapors by means of the atomizer, as described by Wigglesworth. Bumstead and Taylor employ saturated solutions of nitrate of silver, applying the vapor by an arrangement of glass tubes which permit the spray to be directed to the very seat of the disease.

ŒSOPHAGUS.—The occurrence of stricture of the œsophagus as a result of syphilis was, according to Bumstead and Taylor, first pointed out by James F. West, of Birmingham,¹ who reported a case where, without direct evidence of syphilitic disease of the œsophagus, the collateral evidence of such disease, as giving rise to fatal stricture, was very strong. Other cases have since been reported, among them a very interesting one by the late Dr. F. F. Maury, of Philadelphia,² where gastrostomy was performed. As yet, however, direct evidence of syphilitic lesions in the œsophagus leading to stricture has not been presented, though gummata have been found in the walls of the tube. The treatment in suspected cases would, of course, be the usual anti-syphilitic treatment, strongly pushed in the earlier stages. In the cicatricial stage, dilatation with bougies is a palliative measure; or the establishment of an œsophageal or gastric fistula might be resorted to in extremity.

STOMACH AND INTESTINES.—Functional disturbance of the digestive organs, shown by loss of appetite or by inordinate desire for food, as well as by occasional vomiting, is not uncommon, especially during the earlier stages of syphilis. Whether the same organic changes may occur in these viscera as are observed in the external parts during the earlier stages of syphilis, is a question as yet undecided. Late lesions, as gummatous infiltration followed by ulceration of the stomach and intestines, may however occur, and cases of this kind have been reported where post-mortem examination proved the existence of quite extensive disease. The symptoms during life were those of dyspepsia or chronic diarrhœa, but little more.³ In many reported cases, iodide of potassium was employed in large doses by the stomach, or, where this was irritable, in the form of enemata (gr. xv–lxxv to water, ʒiv–vj).

RECTUM AND ANUS.—Many cases of so-called syphilitic stricture of the rectum are, in reality, nothing more than the contraction due to chancreoid ulcers.⁴ In these, of course, specific anti-syphilitic treatment is without avail. The early syphilitic lesions may also, according to Barduzzi, produce stricture of the rectum.⁵ But it is in the later stages of the disease that this condition is most likely to be produced.

Syphilitic stricture of the rectum is much commoner among women than among men. Statistics collated by Jullien show that of 60 cases, 7 were in men and 53 in women. What the reason of this diversity may be, it is impossible to say. Many women date the beginning of their trouble to a previous pregnancy. The affection is commonest in middle life.

¹ Dublin Quarterly Journal of Medical Science, February, 1860.

² Am. Jour. Med. Sci., April, 1870.

³ See Cornil, op. cit., p. 406; Cullerier, De l'Entérite Syphilitique, Union Méd., 1854, t. iv.; Lancereaux, op. cit., p. 248.

⁴ The occurrence of chancre of the rectum is more than doubtful.

⁵ Giorn. Ital. d. Mal. Ven., No. 1, 1875.

The manner in which stricture of the rectum is produced is, in all cases, by the contraction of a cicatrix following an ulcerative lesion or a submucous gumma. The ulcerative lesion is a comparatively early syphilitic development, and often coincides with cutaneous and mucous manifestations. The ulcers, as seen near the anus, are usually elongated in the direction of the swollen anal folds, between which they are often hidden, so as not to become visible until the mucous membrane is put upon the stretch. Further up in the rectum they are roundish, sharply cut, and almost always covered with pultaceous detritus and adherent mucus. To the touch they offer the sensation of a granular, somewhat resistant substance. Their duration is naturally long, and they are subject to phagedæna, owing to the various causes of irritation to which they are exposed. When the syphilitic ulcer of the rectum does heal, cicatrization is apt to cause a valvular stricture, if it has involved a portion, or an annular stricture, if it has extended around a greater part of the circumference of the tube.

Submucous gummata of the ano-rectal region are extremely rare, but their existence is maintained by Jullien.

Diffuse gumma, called by Fournier "ano-syphiloma," is a late lesion, and consists in an infiltration of the ano-rectal walls by a neoplasm of, as yet, undetermined structure, originally, but susceptible of degenerating into a retractile fibrous tissue, and thus giving rise to narrowing of the intestinal calibre to a greater or less degree and extent. It is the most frequent cause of rectal stricture.

Ano-rectal syphiloma is more frequently met with about the rectum than about the anus. In the former position, its chief symptom is a hard, firm thickening of the rectal walls. To the touch, the walls of the rectum are not only hard, but they are rough, mammillated, and divided into thick ridges. The mucous membrane is, both to touch and to ocular examination, perfectly healthy.

It is the lowest portion of the rectum which is the customary seat of the form of syphilis under consideration; it rarely extends to more than two and a half inches beyond the anus. The lesion is indolent in its earlier stages, giving neither pain nor inconvenience.

The anus is rarely affected alone by this lesion, but almost always in connection with the rectum. The lesion here takes a nodular or sometimes a vegetative form.

Treated in good time, the ano-rectal syphiloma, and also the other syphilitic anal and rectal manifestations, may be dissipated and caused to disappear. Neglected, as these affections too often are, they not only persist, but they tend to degenerate, and thus lead inevitably to stricture of the rectum.

Treatment.—To be successful, the treatment of syphilitic disease of the rectum and anus must be undertaken early in the history of the affection. If postponed until cicatrization sets in, anti-syphilitic treatment has but little effect. When cicatrization has begun, it proceeds usually without regard to any treatment which can ordinarily be administered.

The usual anti-syphilitic treatment is, of course, called for, and should be pushed vigorously as long as any chance of success by this means can be hoped for. When constriction of the rectal tube has once fairly begun, internal medication, as has just been said, is of no avail. Dilatation by means of bougies may serve to keep the passages open for an indefinite period, and should be practised assiduously. When this fails, and complete stenosis of the rectum is threatened, operative interference is called for, as will be set forth in other portions of the work.¹

¹ Fournier, in his complete monograph, *Lésions Tertiaires de l'Anus et du Rectum*, Paris, 1875, says that he has known half a dozen patients suffering with syphilitic stricture of the rectum, who, by using dilatation with bougies from time to time, have been able to go about comfortably for five, eight, and ten years.

SYPHILIS OF THE OLFACTORY AND AUDITORY APPARATUS.

OLFACTORY APPARATUS.—The mucous membrane, cartilages, bones, and nerves connected with olfaction, may be affected by syphilis in one stage or another of its evolution. The pituitary membrane may, in the earlier stages of the disease, be the seat of erythema, mucous patches, or superficial ulceration, just as the buccal mucous membrane is the seat of such lesions. Sometimes an erosion or shallow ulcer may be seen within the nasal orifice, surrounded by swollen mucous membrane, and rendering the ala nasi tender upon pressure. Plugs of inspissated mucus, mixed with blood and pus, frequently obstruct the passages, and are from time to time discharged. The character of these lesions is often difficult to make out in the absence of other concomitant syphilitic manifestations, and sometimes only their disappearance under anti-syphilitic remedies serves to show their true nature.

Rhinitis.—In the later stages of syphilis, ulcerative syphilitic rhinitis, or syphilitic ozaena, is met with, one of the gravest of the ulcerative affections of the mucous membranes, and one which is all the more dangerous because so often mistaken for simpler and milder affections, until it has made irreparable ravages.

At the outset, stuffing up of the nostril, with sensitiveness over the affected point, and some catarrh, is observed. From time to time dark spongy crusts covered with blood are expelled, together with an almost odorless, serous fluid, and also mucus. When it has extended more deeply, the affection gives rise to an ill-smelling, sero-sanious discharge, which becomes more fetid as the disease penetrates more deeply. If the affection happens to be seated near the opening of the nares, a roundish, elevated, fungous ulcer, usually covered with a yellow crust, can be seen on the nasal septum or within the ala. The rhinoscope is necessary to examine lesions further within the nasal passages.

Whether the lesion begins in the mucous membrane and penetrates to the bone, or whether the osseous lesion is first in point of time, and the superjacent mucous membrane only becomes involved at a later period, fragments of cartilage and bone are very apt to be denuded, detached, and discharged. In this case the discharge becomes blackish and extremely fetid, the sense of smell is almost or entirely lost, the mucous membrane in the neighborhood of the ulcers becomes swollen and painful, and the nose changes its shape, and, if the septum is attacked, becomes flattened.

The ulcerative process may perforate the floor of the nasal cavity, extend into the pharynx, find its way along the Eustachian tube, and even penetrate the cranial cavity, involving the meninges; more commonly, however, the membrana tympani becomes ruptured, and purulent discharge takes place through the external auditory canal. Deafness may ensue from obliteration of the Eustachian tube by a cicatrix. The disease has been known to pass up the lachrymal canal, involving the lachrymal bone and even the eye (Bumstead and Taylor). Respiration through the nose is usually hindered more or less by the lesions described, and sometimes it is permanently prevented, breathing being entirely performed through the mouth, and the voice having a nasal twang.

Treatment.—The constitutional treatment of syphilis of the nasal passages is that of the disease in general, and its nature must depend upon the stage of the affection and upon the character of the lesions. In addition to mercury and iodide of potassium, tonics and cod-liver oil are frequently called for. The most efficacious local treatment is by means of mercurial inhalations, a sufficient quantity of calomel or of the bisulphuret or binocide of mercury being heated on a metallic plate over a spirit lamp, and the fumes being directed

into the nostrils by a cone of paper or other convenient method. Blood-warm injections of a strong solution of chlorate of potassium or of common salt (3j ad Oj), or of a diluted solution of chlorinated soda (1 part to from 12 to 20 parts of water), are also useful. The nostrils should first be thoroughly cleansed by means of the nasal douche. It is a matter of great importance to follow out a thorough and complete system of cleansing and local medication in these cases, in order to limit and check the progress of the disease as rapidly as possible, and it must be remembered that, as long as there is any necrosed bone to come away there will be a foul discharge, so that the prognosis must be made with this fact in view.

Olfactory Neuritis.—That the olfactory nerves may be attacked by syphilis has been shown by Bayle and Kergardec¹ who cite a case where these nerves were destroyed. Virchow also gives a case where these nerves were lost, so to speak, in the general disorganization of surrounding tissues. Gros and Lancereaux² likewise cite analogous cases. Anosmia is of course the prominent symptom under these circumstances.

AUDITORY APPARATUS.—Syphilis of the ear is comparatively rare. Buck, of New York, met with but 30 cases out of a total of 3976 cases of ear affections, though, owing to the fact that many cases go unrecognized, the proportion is probably larger. Chancre of the external ear has been met with in one recorded instance, and the various syphilitic lesions of the skin are of course encountered here, papules being most apt to occur in the post-auricular angle and upon the lobule of the ear, while the macular syphiloderm is seen in the fossa navicularis and concha. Vegetating papules are found in the external auditory canal, solitary or few in number near the outer opening, but sufficiently numerous and luxuriant further inwards to occasionally fill up the canal and hide the drum. Sometimes vegetations form on the drum itself, when perforation may result. They are accompanied by the discharge of a sero-purulent fluid which causes the affection to look like otitis externa. Simple papules or papulo-squamous lesions are not found within the meatus.

At a later period in the evolution of syphilis, ulcers of roundish form, covered with diphtheritic membrane, are liable to occur within the meatus, and gummata of the cellular tissue, cartilage, or bone, are also met with. Hyperostosis and exostosis may likewise occur in the external bony canal.

The middle ear is that portion of the olfactory apparatus which is most apt to be the seat of syphilitic disease. Chancre of the Eustachian tube has been reported as the result of using unclean aural instruments, and mucous patches are not infrequently met with either in this tube or in the middle ear, sometimes disappearing under treatment, but sometimes ulcerating and destroying the tissues to a greater or less extent.³

SYPHILIS OF THE EYELIDS AND LACHRYMAL APPARATUS.⁴

The various tissues which go to make up the eyelids may each be the seat of one or another of the lesions of syphilis. Chancres of the eyelids have

¹ Nouv. Bibliothèque Méd., quoted by Lancereaux.

² Affections Nerveuses Syphilitiques.

³ For a description of the syphilitic lesions of the middle and inner ear, reference may be made to the article on affections of the ear in Vol. IV. of the present work; to Burnstead and Taylor's Treatise (p. 730 et seq.); and to the following monographs and papers: Gruber, Ueber Syphilis des Gehörorgans (Wien. med. Presse, 1870, 1, 3, 6, 10); Roosa, Syphilitic Affections of the Ear (Am. Jour. Syph. and Derm., 1871, p. 97); Sexton, The Sudden Deafness of Syphilis (Am. Jour. Med. Sci., July, 1879, and Jan. 1880); and F. R. Sturgis, Affections of the Middle Ear during the Early Stages of Syphilis (Boston Med. and Surg. Jour., vol. cii. p. 533, 1880).

⁴ The syphilitic lesions of the eye proper are considered in another article.

been reported; the syphilodermata may affect the skin of the lids; mucous papules or mucous patches may occur upon their commissure; the glands may be involved, causing blepharitis; and gummata of the angle of the eye are not very rare. Most of these lesions are easily distinguished from the non-syphilitic affections which they resemble. A form of late ulceration occurring near the free border of the lids is liable to be mistaken for *ophthalmia tarsi* or *epithelial cancer*, but the history, and in a last resort the touchstone of treatment, will settle the question. Bumstead says that non-ulcerating gummatous nodules from small-pea to filbert size occur in the lids, the skin over them being unchanged in color or appearance. These may sometimes remain unaltered for a considerable period, and are liable to be mistaken for *tarsal* or *meibomian tumors*. They may usually be resolved by the free use of antisypilitic remedies, especially the mercurials.

Syphilitic inflammation of the *tarsal cartilages* is characterized by a thickening from inflammatory infiltration of the cartilage, which usually retains its shape, and from swelling of the lid, in which the skin may or may not be involved. The cartilage is apt to lose its normal elasticity. The affection is obstinate, lasting weeks or months, and is apt to be followed by loss of the cilia.

The affections of the *lachrymal ducts* have been carefully studied by various writers, among others by Lagneau,¹ who says that they are generally due to some osseous lesion—periostosis, exostosis, caries, or necrosis; more rarely they are due to some lesion of the soft parts. The chief diagnostic marks are the presence of an indurated, resistant swelling, of a bony character at bottom, perceived by the touch at the lower and internal portion of the orbit, or by the sound in the nasal duct. The syphilitic character of the cutaneous orifice of the fistula, when one exists; the coincidence of late syphilitic lesions in the neighborhood, or elsewhere; and the history of the case, will also throw light on the nature of the disease. The course of the affection is slow, with occasional erysipelatoid attacks. Internal treatment, employed at an early stage, must be relied upon.

SYPHILIS OF THE GENERATIVE APPARATUS.

PENIS AND URETHRA.—The *urethra*, both in the male and in the female, may be the seat of various syphilitic lesions analogous in most respects to those occurring in the respiratory and alimentary passages. The cavernous structure of the *penis* may be the seat of a gummatous deposit which may give rise to a sort of chordee; the affected section of the penis being flaccid during erection, the organ assumes a curved shape, and is pointed in one direction or another according to the seat of the gumma. Other deposits in the cavernous portion of the penis may give rise to the same symptom, which is not, therefore, peculiarly characteristic of syphilis.

Bumstead and Taylor² speak of a tubercular or gummy ulcer of the penis which closely resembles chaneroid, with sharply-cut edges and grayish excavated floor, an abundant purulent secretion, and a soft base, seen most frequently in the furrow at the base of the glans, where it tends to undermine the integument of the penis.³ This sore, however, is solitary, while chaneroid is usually multiple.

TESTICLE.—*Syphilitic Epididymitis*.—First described by Dron⁴ in 1863,

¹ *Maladies Syphilitiques des Voies Lachrymales.* Arch. Gén. de Méd., 1847.

² *Op. cit.*, p. 361.

³ See Pl. XXII., Fig. 3.

⁴ *De l'Epididymite Syphilitique.* Arch. Gén. de Méd., 1863.

this affection is characterized by the insidious occurrence of a small, smooth, round or oval tumor just above the testicle, the latter and the scrotum itself being unaffected. Its size varies from that of a pea to that of a Lima bean. It is indolent, and may exist for a long time unchanged. It readily disappears under the influence of mercury. This affection is a rather early manifestation of syphilis, occurring in most cases within the first six months. It may, however, show itself as early as the second month, or as late even as the fifth year after infection. It may be confounded with *tubercular epididymitis*, and has sometimes been mistaken for the result of *acute or chronic urethral inflammation*. An important point in the diagnosis of the affection is that it attacks the globus major, whereas in *gonorrhœal epididymitis* the globus minor is most commonly involved alone.

Syphilitic orchitis may occur as soon as the fourth or fifth month after contagion, while early symptoms are still present; but in the majority of cases it does not appear until several years after the primary sore, and is accompanied by well-marked late manifestations in the fauces, periosteum, or bones; or in some instances it is the only evidence of syphilitic disease which the patient presents.

Syphilitic orchitis commonly attacks both testicles, either at the same time or one after the other. The testicle becomes enlarged, without pain, even on pressure, or any sign of inflammation. There is a feeling of weight, especially towards evening, as the testicle grows heavier, and sometimes a dull pain is felt about the loins; but there is no nocturnal exacerbation, as is usual with many syphilitic troubles. The testicle is somewhat increased in volume, but rarely above double its normal size. Some of the apparent swelling is due to hydrocele, as there is in nearly all cases a slight effusion into the tunica vaginalis. When considerable effusion is present, it may be necessary to evacuate the fluid before the condition of the testicle can be ascertained, but commonly a little manipulation will enable the gland to be grasped and examined. At an early stage in the disease, small indurated nodules, of a gummatous character, can sometimes be felt upon the surface of the testicle, and at a later period these may coalesce and form an indurated tumor, but without giving rise to great irregularity of outline. Sometimes the tumor is smooth from beginning to end. The course of the affection is slow, frequently lasting for several years. Left to itself, it frequently terminates in obliteration of the seminiferous tubules and partial or complete atrophy; at other times the parenchyma of the gland may degenerate into fibrous, cartilaginous, or even osseous tissue. It was formerly supposed that suppuration never took place in uncomplicated syphilitic orchitis, but it has been shown that this result is occasionally observed.¹

There are two forms of syphilitic orchitis, pathologically considered. In the first or diffuse form, a sub-inflammatory condition is found, with diffuse cell-infiltration and effusion. In the circumscribed variety, there are gummatous nodules scattered through the body of the testicle. The two varieties may occur together.

Syphilitic orchitis may be confounded with gonorrhœal epididymitis, with cancer, with tubercular disease of the testis, or with simple chronic orchitis. The *gonorrhœal* affection is so clearly inflammatory in its character—being attended by severe pain, difficulty of motion, redness, heat, and tension of the scrotum—that these symptoms alone should suffice to distinguish between the two conditions. In *cancer* of the testicle (generally encephaloid), the pain, slight at first, increases with the progress of the disease, and becomes very severe and

¹ Secondary softening of the interior sometimes takes place. See Lancereaux, op. cit., 2me éd., p. 221, and for an illustration, Ibid., Pl. I. Fig. 9.

lancinating; the tumor is irregular in shape, grows with great rapidity, and often attains an immense size; and the cord and neighboring ganglia are frequently involved. *Tubercular* disease of the testis comes on about puberty in strumous subjects; the deposit occurs in the epididymis or in the centre of the testis; adhesions with the scrotum and tunica vaginalis occur, and suppuration and ulceration may follow. Evidences of tubercular deposit may often be detected simultaneously in the vesiculæ seminales, by examination with the finger *per anum*, or in the cord or inguinal ganglia. *Chronic orchitis* is a very rare affection, and the diagnosis between it and the disease under consideration can usually be made by exclusion.¹ In cases of doubtful diagnosis, it is always best to wait, and, if necessary, attempt a cure by specific medication before operating. It is said, on good authority, that many patients suffering from curable syphilitic orchitis have been uselessly castrated by rash operators.

Iodide of potassium combined with mercury is the best remedy in syphilitic orchitis, which will often yield to the "mixed treatment" when the iodide alone, even in large doses, has failed. With broken-down patients, mercurial inunctions, with iodide of potassium and tonics internally, form the best treatment. The testicle may be supported by a suspensory, and, in case the effusion into the tunica vaginalis is excessive, it may be evacuated by means of a lancet or broad needle. The danger of wounding the swollen testis is too great to admit the use of a trocar, as employed in the ordinary method of tapping for hydrocele.²

SYPHILIS OF THE FEMALE GENERATIVE ORGANS.—In addition to the early manifestations of syphilis—chancre, moist papules, mucous patches, etc.—which have been already described as they are found upon the external genitalia of the female and upon the cervix uteri, other later lesions, chiefly tubercular and ulcerative-tubercular in character, are found in these parts. They do not, however, present any peculiarities worthy of special note.

Syphilis of the *uterus* and its annexes, however, requires some special mention. With regard to the uterus itself, some doubt exists as to whether syphilis in its later forms has been known to attack this organ. It seems likely, however, that certain cases of so-called cancer of the uterus are nothing more than ulcerated tubercular or gummatous deposits, since, in one or two instances,³ specific treatment has brought about a cure when cancer had been diagnosticated and a fatal result looked for.

Lecorché and Lancereaux⁴ have reported cases where the *ovaries*, in undoubted syphilitic cases, appeared at the autopsy to have been the seat of diffuse or sclerous syphiloma. These cases showed no clinical sign of the disease found. Gummatous tumors of the ovaries, as in a case reported by Lancereaux, have shown their existence by objective symptoms during life, in the shape of egg-sized enlargements, elongated in the direction of the broad ligament, quite perceptible in the ovarian region, and disappearing under the use of iodide of potassium. Richet also reports a case where autopsy revealed an undoubted gummatous tumor in the substance of an ovary.

¹ Bumstead and Taylor (op. cit., p. 637) give the more prominent symptoms of chronic orchitis. Curling (On the Testis, 2d ed., London) may also be referred to in this connection.

² Bumstead and Taylor.

³ Cited by Jullien, op. cit., p. 934.

⁴ Jullien, op. cit., p. 935.

SYPHILIS OF THE KIDNEY.

The earlier disturbances of the urinary function have been already mentioned (page 376). The affections of the kidney about to be described are of later date, and of more serious significance.

Syphilis of the kidneys is of two varieties, pathologically dissimilar, but clinically not to be differentiated. One is characterized by gummatous deposits; the other is a diffuse nephritis, not unlike the diffuse syphilitic sclerosis of the lungs and testicles.

In both forms of syphilitic kidney-trouble, the affection begins in an insidious manner. After a time the effect of the renal disease comes to show itself in the system at large; the patient becomes pale and weak, suffers from general malaise, with gastric disturbance, nausea and vomiting, headache, lumbar pain—in a word, the usual symptoms of beginning renal disease. At a later period, œdema about the ankles, puffiness of the face, and extravasations into the serous cavities follow, as do also epistaxis and hæmoptysis. At this stage the polyuria and albuminuria become somewhat lessened; the patient is like the subjects of ordinary Bright's disease, and, unless the morbid process can be arrested, goes on through anasarca, ascites, "indolent" pleurisy, lesions of the eye and brain, and finally complete cachexia, to death.

It will be observed that the symptoms just mentioned are manifested by syphilitic kidney affections in common with non-syphilitic renal troubles, but as regards prognosis the difference is very marked. Taken in time, and appropriately treated by means of mercury and iodide of potassium, together or alone, the morbid process is arrested, amelioration can be hoped for in many cases, and it is not rare even to obtain a complete cure.¹

Of course, it is understood that timely measures are carried out; the treatment should be prompt, thorough, and persistent, from the moment when the nature of the affection is understood.

SYPHILIS OF THE LIVER.

EARLY HEPATIC SYPHILIS.—The earliest manifestations of syphilis in the liver have already been described (page 375), but those which occur at a later period in the history of the disease are of more importance and deserve a fuller discussion. In what may be called the middle stage of the early evolution of syphilis, the liver is now and then attacked in the same manner as in the earlier period already described, but to a rather more marked degree. This form is met with from two and a half to three months after the first outbreak of generalized symptoms, and is accompanied by hypertrophy of the liver, pain, and sometimes icterus, together with certain concomitant symptoms to be mentioned. The liver begins to enlarge at an early period, and continues to increase in volume until treatment is instituted. It remains stationary for a time under treatment, and then begins slowly to decrease in size, but with interruptions caused by recurrent attacks of congestion, alternations of amelioration and aggravation occurring without ostensible cause. The volume of the liver is variable, but in some cases the organ may rise as much as two fingers' breadth above the floating ribs in the line of the nipple, and may form a more or less prominent tumor in the line of the sternum.

Pain is a constant symptom. Weight in the hypochondrium, difficulty of locomotion which aggravates the pain, and increased distress with lancinat-

¹ See Fournier (op. cit.), for a striking case illustrating the curability of this affection.

ing pain on percussion or palpation, are characteristic symptoms. The pain leaves before the hypertrophy has been entirely reduced by treatment.

Icterus is not a constant symptom. When present, it comes on after the hypertrophy and pain, and disappears with those manifestations. When observed, it is intense, with scanty, bile-colored urine, and clayey stools; but none of these symptoms persists more than a few days after treatment has been instituted.

As was observed above, in treating of the earliest forms of syphilitic liver trouble, gastric and intestinal catarrh are absent. The digestive disturbances noted supervene *after* the appearance of the hepatic disorder, and are accounted for by the condition of the liver. Loss of appetite is observed, while the tongue is moist and normal in appearance. Digestion is slow and difficult, and accompanied by sensations of weight and discomfort in the epigastric region, and by a tendency to constipation. The other symptoms of syphilis, eruptions of various kinds, cephalalgia, etc., usually relapse or break out afresh coincidently with the appearance of the hepatic disorder, and it has been observed that in some cases the spleen and kidneys are involved at the same time.

The *diagnosis* of this form of syphilis of the liver, which it may be mentioned is a rather rare affection—if we may judge from the scanty records published—must be made chiefly by exclusion. There is scarcely any affection excepting syphilis which can give rise to this sub-chronic condition of the liver, and of course the coincidence of other syphilitic manifestations is an important aid.

The *prognosis* is more serious than in the earlier form of hepatic trouble, and it is likely that the repeated congestive attacks and relapses which mark the course of the affection, point to a *locus minoris resistentiæ* which may be the seat of subsequent attacks of syphilitic disease of a more serious character. The coincidence of other visceral manifestations, and the fact that when eruptions of the skin occur in this connection they are often of the type called “precocious” and “malignant,” also mark the affection under consideration as one of serious import.

The *treatment* should be prompt and energetic, every effort being made to build up the patient at the same time that specific remedies are administered with a free hand. The “mixed treatment” is that to which recourse should be had, and in order to save the stomach as much as possible, mercurial inunction may be combined with the internal administration of iodide of potassium, beginning with the dose of five grains thrice daily, given immediately after eating, and rapidly increasing this to ten grains or more at a dose, care being taken to avoid irritation of the stomach. (See remarks on treatment.) Tonics, such as iron and quinine, nourishing food, douche and other baths, and change of air and scene, may be required in one case or another. It must be remembered that it is not merely a patient with liver trouble that must be treated, but at the same time an individual poisoned by an unusually severe attack of syphilis, which may even threaten life in its later stages, if these, its earlier manifestations, are not deprived of their virulence and crushed out.

Among local remedies various revulsives may be used. Dry cupping, and afterwards, flying blisters, are perhaps the most satisfactory in their effects. It must not be forgotten that even after the patient appears to be cured, relapses may take place, and that the antisyphilitic treatment should be kept up for a long time, or, if this is impossible, should be resorted to for short periods at intervals.

LATE HEPATIC SYPHILIS.—The late syphilitic lesions of the liver manifest themselves under two forms—1. Interstitial hepatitis. 2. Gummatous hepa-

titis. Lacombe¹ considers these two forms as anatomically the same, but they are best described separately. Some authors consider amyloid degeneration of the liver as a syphilitic lesion, but it is rather the effect of a cachexia which may or may not be syphilitic in origin. Again, perihepatitis has been considered as an independent affection, but recent writers regard this as merely the result of interstitial hepatitis.

In perihepatitis, the lesions are situated in the fibrous envelope of the organ, which is thickened, and which shows marked adhesions attaching it to the neighboring organs, particularly the diaphragm. The membrane sometimes contains a greater or less number of small, hard, whitish nodules.

In interstitial hepatitis, the volume of the organ varies according to the stage of the disease. In the earlier stage it is hypertrophied, in the later stage atrophied and shrunken. The color of the organ is changed to a more or less bright yellow on the surface, and in section, when also white striæ formed by the prolongations of the hypertrophied fibrous membrane can be seen.

In the gummatous form of hepatitis, a more or less considerable number of gummy tumors, similar to those observed in the cellular tissue, are found in various stages of evolution. Virchow has described a syphilitic lesion of the liver which assumes the form of cicatrices. The surface of the liver is also found to show loss of substance at circumscribed points, replaced by whitish stellate patches, the prolongations of which penetrate more or less deeply into the tissues beneath. The biliary canals and vessels are rarely intact; sometimes they are found to have entirely disappeared. The lesions may occupy the entire organ or only a single lobe.

Syphilitic affections of the liver are most apt to occur in individuals who have not been properly treated during the early stages of their disease, either because of neglect, or because the earlier manifestations were so trifling as to escape notice. It is commonly met with between the ages of thirty and forty. Extraneous influences, such as traumatism or superactivity of the organ, predispose to the disease. Alcoholism is a recognized predisposing cause.

Symptoms.—The symptomatology of syphilis of the liver is by no means as well understood as its pathology. The course of the disease may be divided into three stages, corresponding to the pathological changes which take place in the affected organ.

(1) The *first stage*, corresponding to that of connective tissue hyperplasia—hypertrophy of the liver—is characterized by enlargement of the organ to a degree perceptible to external examination. Percussion shows dullness, sometimes extending two or three finger-breadths above the floating ribs, while the tumor can be seen in the epigastric region. This hypertrophy is a late manifestation; it may occur from three to four years after the early syphilitic symptoms, or in some cases as late as twenty years. Its duration is very variable. It may increase by successive exacerbations.

Pain is a characteristic symptom. Usually of a dull dragging character, and aggravated on walking, it may occasionally occur in acute paroxysms of much greater severity, especially at night. The pain radiates toward the epigastrium, the iliac fossa, and the kidneys. It gives rise to such sensitiveness that the least pressure causes distress, and that patients cannot at times even so much as button the clothing.

Icterus, usually succeeding the hypertrophy, is an occasional symptom of this period of hepatic syphilis. It is supposed to be due, under ordinary circumstances, to extension of the inflammation to the bile-ducts, and to obliteration of these by desquamation. Another explanation, suggested by the

¹ Étude sur les Accidents Hépatiques de la Syph. chez l'Adulte. Thèse de Paris, 1874.

observations of Virchow and others, is stoppage of the biliary passages by pressure from a gumma. Clinically, the icterus in the first of these cases is more marked, but not as persistent, as in the second case—that of compression by a gumma.

Ascites is occasionally observed, though not to a marked degree. It is due to involvement of the hepatic vessels interfering with the circulation in the liver.

The chief characteristic of these various symptoms of the first period of hepatic syphilis is that of being curable. They yield with tolerable promptitude to antisyphilitic treatment.

In addition, the spleen and kidneys may be involved simultaneously, ulceration of the pharynx is very apt to be present, and various other symptoms of syphilis may coexist to make the diagnosis easy. It should be remarked that digestive troubles are not usually present.

(2) The *second stage* is unmarked by any physical or functional symptoms of a characteristic nature.

(3) The *third stage* is marked by physical and functional symptoms. Atrophy is generally well marked, but as atrophy of one part of the liver is at times compensated by hypertrophy of another, percussion must be made very carefully, when it will show marked irregularity of outline—atrophy in one place, hypertrophy in another. Occasionally, irregularities and lobulations can be perceived by manipulation of the edge of the liver. Sometimes the abdominal walls will be observed to be immobile during respiration, instead of gliding over the surface of the liver, as in the normal condition.

Among the functional signs, *icterus*, although sometimes observed, is rare. *Ascites* is well marked, beginning slowly and insidiously, through the period of a month or more, and then suddenly developing to a considerable degree within four or five days, so as to interfere with locomotion and to hinder respiration, requiring puncture at times, and even then oftentimes returning with increased rapidity. *Ascites* is a grave symptom when it appears; little or no relief can be expected from treatment.

Digestive disturbances constitute a marked feature of the affection under consideration. They arise in part from the condition of the liver, and in part from the general cachexia. Vomiting is an early symptom; it may precede all others. Diarrhœa, on the other hand, is more frequent in the later stages of the disease, when it is met with in six cases out of seven. The stools are pale and discolored if there is retention of bile. The intestinal functions are likewise imperfectly performed; there is meteorism; the abdomen is distended; and, as nutrition does not go on perfectly, the patient becomes thinner day by day.

The course of hepatic syphilis is slow, progressive, insidious, or even concealed. In some cases it runs its course without giving rise to any perceptible external symptoms. Its duration is long, unless when an extension of the ascites or some complication causes death, and it may exist months or years without causing any considerable disturbance of the system at large. The affection terminates most frequently by producing marasmus and cachexia.

Diagnosis of Hepatic Syphilis.—Syphilis of the liver is to be distinguished from *cancer*, *hydatid cyst*, and *drunkard's liver*. The diagnosis is at times very difficult, but attention to the following points may aid in distinguishing doubtful cases:—

Cancer only shows itself at an advanced age, fifty or sixty years on an average. It invades both lobes at the same time. Pain is more severe; there is vomiting, rapid depression of the vital forces, and special cachexia. The affection does not last more than from six months to two years. *Icterus* is

very marked, or at least the characteristic discoloration of the cancerous cachexia.

Hydatid Cyst.—A fluctuating, globe-like projection, larger than that of the syphilitic disease, advancing toward the epigastrium, and often simulating a lesion of the stomach. Pathognomonic vibratory trembling. Digestive troubles. Dyspnoea. Ascites rare.

Drunkard's liver is distinguished anatomically from syphilis of the liver by its localization at the periphery of the lobule. The neoplasm incloses the lobule, but does not penetrate it—does not interpose between the cellulæ. Clinically, the lesions are more extensive than those of syphilis; ascites is more frequent. The course of the disease is slow. There are various digestive symptoms coincident: dyspepsia and anorexia; also nervous disturbances, as formication, cramps, and trembling.

The *prognosis* of hepatic syphilis is grave. If the affection can be taken in time it may be cured in many cases, but if atrophy has set in, the prognosis is very serious.

Treatment.—The “mixed treatment” offers the best chance for a cure. It is better than the use of either mercury or iodine alone.

The literature of hepatic syphilis, particularly that which relates to the pathological anatomy of the disease, is very abundant, much attention having been paid to the subject in the last few years.¹

SYPHILIS OF THE RACEMOSE GLANDS.

MAMMARY GLANDS.—The mammary glands are rarely attacked by syphilis, but twenty cases, according to Jullien, are on record. The affection is of two kinds, diffuse sclerous infiltration, and localized gummy deposit.

The first variety is apt to be met with among men. It is a comparatively early manifestation, and is characterized by diffuse tumefaction, by tenderness on pressure, without external inflammatory appearance, and by rapid disappearance under specific treatment.

The gummatous affection of the mammary glands is a late syphilitic manifestation, and is much commoner among women. When first noticed, the gumma is often buried deeply in the tissue of the mammary gland, and may easily be mistaken for an *adenoid* tumor. It grows in size, however; sometimes attaining that of an egg or an apple, or even (in one case reported by Sauvage) that of a child's head. The tumor is irregular and bosselated, and sometimes accompanied by ganglionic engorgement. As it approaches the surface of the skin, fluctuation, or at least the sensation of a softened infiltrated tissue, is perceived, a point of decided diagnostic importance. If not influenced by treatment, the skin softens, and an ulcer is formed.

It is not always easy to distinguish this lesion from *cancer*, and, unless some concomitant and unmistakable syphilitic symptoms are present to guide to a conclusion, the only plan to follow is to use the “touchstone of treatment.” But an unnecessary surgical operation may be avoided, perhaps, by giving in doubtful cases the iodide of potassium, or perhaps the “mixed treatment,” and watching its effects.

SALIVARY GLANDS.—Lancereaux has reported a case where the *submaxillary* gland, in a patient dying in full tide of syphilis, was found affected by

¹ The following writers may be particularly referred to, and in their works will be found numerous references to the contributions of others: Lancereaux, *Traité de la Syphilis*, 2e éd. Paris, 1878; Quinquand, *Affections du Foie*, Première Fascicule; Lacombe, *Thèse de Paris*, 1873; Lendet, *Recherches Cliniques sur l'Étiologie, la Curabilité et le Traitement de la Syphilis Hépatique* (Arch. Gén. de Méd., Fév. 1866); Cornil, *Leçons sur la Syphilis*. Paris, 1879.

diffuse syphilitic sclerosis. Fournier has reported a case of syphilitic disease of the *sublingual* gland; the patient, while suffering from generalized syphilitic symptoms, was attacked by a tumor the size of a date, which could be perceived in the right sublingual fossa, and was firm and hard to the touch. The administration of iodide of potassium reduced the tumor in a few days to its normal volume. Verneuil has reported a somewhat similar case, in which, however, the nature of the tumor was not made out at the time.

PANCREAS.—Lancereaux says that, in many autopsies of syphilitic subjects, the pancreas is found indurated by sclerosis. He also reports a case of gumma of the pancreas, this, with the addition of one reported by Rostan, being the only cases on record.¹

SYPHILIS OF THE SPLEEN, SUPRA-RENAL CAPSULES, AND THYROID GLAND.

SPLEEN.—The condition of the spleen in the early stages of syphilis has already been alluded to (page 374). Like the lymphatic ganglions, the spleen is almost always attacked by early syphilis, but the later and severer stages of the disease leave it untouched in the vast majority of instances. In the few cases observed after death, gummy deposits were noted in some, but they were usually small and few in number. They were usually situated in the connective tissue of the capsule. Diffuse syphiloma of the spleen is characterized by partial hypertrophy of the organ, the tissues of which are condensed and of a dark-brown color. At a later period, grayish patches are observed, which terminate in depressed cicatrices. Clinically, the affection has rarely, if ever, been recognized.

SUPRA-RENAL CAPSULES.—The supra-renal capsules are often found enlarged in syphilis. Virchow has seen them surrounded by fatty degeneration. Chvostek² has reported an interesting autopsy. No clinical facts are known.

THYROID GLAND.—Lancereaux³ has observed enlargement of the thyroid gland in numerous autopsies of syphilitic subjects. Microscopic examination shows increase of the glandular elements, with occasional fatty degeneration.⁴

SYPHILIS OF THE RESPIRATORY PASSAGES.

LARYNX.—It was formerly thought that all syphilitic diseases of the larynx were propagated from pre-existing lesions in the pharynx, and that they were closely assimilated to these as regarded the period of their develop-

¹ The following references may be made by any one interested in the scanty literature of the subject of syphilis of the racemose glands: Verneuil, *Tumeurs gommeuses du Sein* (Bull. de la Société Anatomique, 30e année, p. 96); Ambrosoli, *D'une Maladie de la Glande Mammaire qui quelquefois s'associe avec différentes formes de la Syphilis* (Gazz. Med. di Lombard, No. 36, 1864); Icard, *Note sur un Cas de Tumeur Syphilitique simulant un Cancer du Sein* (Jour. de Méd. de Lyon, t. vii. p. 21, 1867); Paul Horteloup, *Des Tumeurs du Sein chez l'Homme* (Thèse d'Aggrégation, p. 42, 1872); Lancereaux, *Traité de la Syphilis*; Fournier, *Dégénérescence Syphilitique de la Glande Sublinguale* (Annales de Dermatol. et de Syphiligr., t. vii. p. 81); Rostan, *Altération Syphilitique du Pancréas* (Bull. de la Soc. Anatom., p. 86, 1855).

² Wien. med. Wochens., Aug. 1877.

³ Op. cit., p. 287.

⁴ The following references may be made to recent articles on syphilis of the spleen and supra-renal capsules: Moxon, *Syphilis of the Supra-Renal Capsules* (Guy's Hospital Reports, 3d s., vol. xiii. p. 339, 1868); Huner, *Syphilis of the Spleen* (Deutsches Arch. f. klin. Med., Bd. v., S. 270, 1869); Besnier, *Syphilis of the Rate* (Dict. Encyc. des Sci. Méd., Art. RATE, 1874); Chvostek, *Syphilis of the Supra-Renal Capsules* (Wiener med. Wochenschr., Aug. 1877).

ment and their general character. It is now known, however, that the syphilitic lesions of the larynx may occur at any period of the general development of syphilis, without regard to the appearance of other lesions.

The superficial syphilitic lesions of the larynx include erythema, mucous patches, superficial ulcerations, and vegetations. The deep lesions are deep ulcerations, gummatous tumors, perichondritis and chondritis, caries, and necrosis.

The farther from the opening of the larynx is a lesion situated, the more serious is it. But the severity and threatening character of a lesion are by no means proportioned to its individual character. There is often more to be dreaded from a shallow mucous patch accompanied by œdema, than from a deep ulceration. The subjective symptoms connected with syphilis of the larynx are comparatively trifling. Quite a large and deep ulcer may exist without the patient being even aware of its presence. The invasion of the larynx is insidious, and the subsequent course of the lesions is chronic and devoid of pain. According to the views of some authorities, the parts of the vocal organism most often in contact during the performance of its function are most frequently attacked by syphilis. Hence the vocal cords and the arytenoids are the most susceptible regions (Bumstead and Taylor).

The lesions of laryngeal syphilis are rarely painful, excepting when the cartilages are attacked. There is rarely any cough, and but slight expectoration, this, if present, being scanty, mucous, or muco-purulent. The sputa may be tinged with blood from an ulcer, or may contain fragments of cartilage or bone. In the latter case they are apt to be fetid. The voice is rarely altered, although in some cases there may be hoarseness or whispering. Dysphagia may occur in rare cases where the disease is far advanced, or where the epiglottis is attacked. Dyspnea is an important symptom. It may supervene on stenosis of the passage caused by œdema, vegetating growths, cicatricial contraction, and possibly spasm. Tracheotomy is sometimes called for, but it should only be employed at the last moment, since prompt and vigorous specific medication—if necessary, by the hypodermic method—will sometimes save an apparently desperate case.

In considering the special lesions of the larynx, it is scarcely necessary to more than mention the early and slighter affections. *Erythema* is easily made out when concomitant symptoms are present, or when a trustworthy history can be obtained. When the epiglottis is involved, it may become œdematous and much tumefied, and may assume a bilobed shape.

There has always been some question as to the relative frequency of *mucous patches* in the larynx, but recent writers, such as Krishaber, Mauriac, and Whistler, consider them tolerably frequent. They possess in general very much the same characters in the larynx as in the mucous membrane of the mouth; but the difficulty of examining them closely, and the more complicated arrangement of the parts, render them less easy of recognition in some cases.

The *superficial ulcerations* in laryngeal syphilis involve only the mucous membrane. They are very sluggish, persisting with slight change for an indefinite period. They are apt to be confounded with the ulcers of phthisis, but these begin in the ventricular bands, and are paler than the syphilitic lesions. The ulcers of phthisis are bathed in a copious, muco-purulent secretion, and are apt to be accompanied with decided swelling and œdema of the arytenoids. Finally, the concomitant symptoms of phthisis are likely to be found elsewhere.

The *chronic inflammation* of laryngeal syphilis may be an early or a late lesion; it is apt to be persistent, and to lead to thickening or hypertrophy of

the mucous membrane, quite a different symptom from the œdema sometimes accompanying erythema. Operative interference is occasionally called for to relieve accompanying dyspnœa.¹ Chronic ulcers and occasionally vegetations are found in connection with this form of inflammation, the favorite seat of vegetations being at the insertion of the inferior vocal cords.

The *deep ulcerations* of laryngeal syphilis may occur by extension from the pharynx, or by degeneration of gummatous deposit. They are insidious, and much destruction may occur in the epiglottis, the ligaments, and the vocal cords, without very marked symptoms. These ulcers, which present a similar appearance to those occurring on other mucous membranes, are sometimes mistaken for cancer; but in this disease the tonsils and submaxillary glands are apt to be affected at an early period with infiltration. Pain, sometimes extreme, is a symptom of cancer, but is absent in syphilis until the parts have been extensively destroyed.

Gummy tumors of the larynx are often single, and may attain a large size; but they may also be small and multiple. They generally tend to ulceration. A fatal termination may ensue in the course of these lesions from impediment to respiration, due to the size of the tumor, or to an acute œdema of the larynx. Türk has recorded a case of death from hemorrhage.

Perichondritis usually occurs from extension of an inflammatory or ulcerative process from the mucous and submucous tissues. The cartilage itself may be involved, in which case it is said that crepitation can be observed on palpation.

Caries, or true *necrosis*, when ossification of the cartilage has taken place, is a common sequel of invasion of the perichondrium by inflammation or gummatous ulceration. Fragments of sequestrum may be expectorated, or, lodging in the air passages, may cause alarming or even fatal dyspnœa. Mauriac gives an account of a peculiar phlegmonous inflammation of the parts surrounding the larynx, secondary to the invasion and death of the cartilage.

Syphilitic aphonia has been observed from time to time. Its cause, when occurring in the earlier stages of syphilis, has, I believe, not yet been pointed out; but Simyan and Paget describe a paralysis of the vocal cords which has been observed in the later stages of syphilis. It is unilateral, and yields to specific medication.²

TRACHEA AND BRONCHI.—The syphilitic affections of the trachea and bronchi are naturally closely analogous to those of the larynx. The lower portion of the trachea is the usual seat of the disease. The lesions are commonly developed in the submucous tissue rather than in the mucous membrane itself; they consist either of diffuse infiltration into the submucous

¹ See the account of a case in which tracheotomy was performed four times in five years. Trans. Clin. Soc., vol. x., 1877.

² The following papers may be referred to for fuller details: Gerhardt und Roth, Ueber syph. Krankheiten des Kehlkopfes (Arch. f. path. Anat., Heft. xxii. 1861); Krishaber, Contribution à l'étude des troubles resp. dans les Laryngopathies Syph. (Gaz. Hebdom., 1878, Nos. 45-47); Elsberg, Syphilitic Memb. Occlusion of Rima Glottidis (Am. Jour. Syph. and Derm., 1874); P. Ferras, De la Laryngite Syphilitique (Thèse de Paris, 1874); Krishaber et Mauriac, Des Laryngopathies Syph. pendant les premières phases de la Syphilis, Paris, 1876; Whistler, The Early Manifestations of Syphilis in the Larynx (Med. Times and Gaz., 1878, Nos. 1473 to 1484); Simyan, Syphilis Laryngée Tertiaire (Thèse de Paris, 1877); Mauriac, Sur les Laryngopathies Syph. Graves compliquées de Phlegmon péri-laryngien, Paris, 1876; Simyan et Paget, Des Paralysies du Larynx (Thèse de Paris, 1877); Dance, Éruptions du Larynx survenant dans la période secondaire de la Syphilis, Paris, 1864; Trélat, Sur la Trachéotomie dans les lésions syphilitiques des Voies Respiratoires (Bull. de l'Acad. de Méd., Déc. 8, 1868); Bryant, Trans. Clin. Soc. London, vol. i. 1868, p. 127; H. L. Williams, St. Barthol. Hosp. Rep., 1869, p. 124; T. G. Wollaston, Liverpool Med. and Surg. Rep., vol. iii., 1869, p. 20; Erichsen, Med. Times and Gaz., April 8, 1871; W. Stokes, Brit. Med. Jour., April 1, 1871.

tissue or of circumscribed gummatous tumors. In the bronchial tubes the lesions are apt to be found near the bifurcations.

The *symptoms* which mark the syphilitic affections of the trachea and bronchi vary somewhat according to the nature of the lesions. Their earlier appearance and progress are insidious, and patients are frequently ignorant of their existence. A slight difficulty of respiration, a little cough, and the feeling as of something in the air passages perceived about opposite the upper end of the sternum, comprise the ordinary symptoms. The respiration may also be a little harsh or hissing in some cases, there may be some oppression on going up stairs, or a sense of suffocation at night, with a dry cough. At a more advanced stage of the affection the cough is more frequent and troublesome, and mucopurulent sputa, striated with blood, or nummular, yellowish-green sputa, are observed. Auscultation fails to reveal any abnormal respiratory sound. The symptoms mentioned persist for some time and then begin to diminish, especially if appropriate medication is employed. The amelioration is not permanent, however, for when cicatrization begins, the symptoms previously observed once more set in, only in a more marked degree, and with less hope of improvement through medication. One of the most important symptoms observed at this period occurs in the form of suffocative attacks coming on suddenly, and without any well-defined cause, and sometimes so severe and so frequently repeated as to endanger life. Lowering of the larynx and immobility of this organ during speech and deglutition, are likewise to be noted as important symptoms of tracheal syphilis at an advanced stage. In addition, a peculiar hardness of the trachea may be perceived by the touch, and a diminished degree of mobility on the part of this organ among the surrounding tissues. It is said that one may at times perceive the lesions *in situ* by the aid of a laryngeal mirror, but this view I fear will not often be granted excepting to the expert laryngoscopist.

When the disease affects the bronchial tubes only, the symptoms are somewhat different from those described above. It was formerly supposed that the bronchial tubes were only affected secondarily from the throat, or at least subsequently to it, but this is very frequently not the case. The first symptoms are very similar to those of ordinary catarrh. The voice is altered, however; there is continual dryness and irritation in the larynx, which gradually extends to the bronchial tubes. Patients suffer from a sensation of painful constriction over the sternum, with a dry cough. At a later period the sputa appear of a purulent character, and indicate suppuration. Hectic fever is now observed, if it has not previously appeared; dyspnoea is common; and the patient may finally die in an attack of suffocation. These affections are rare, and often fatal, especially when the trachea is involved, because of the difficulty of recognizing the disease in time to apply proper remedies.

The *diagnosis* of syphilis of the trachea and bronchi is chiefly made by observing the symptoms of dyspnoea, a peculiar wheezing sound in inspiration—the voice preserving almost its natural timbre—pain, or a sensation of a foreign body at some point in the air-passages, and, subsequently, attacks of suffocation without appreciable pulmonary lesion.¹

As to the *treatment* appropriate to these affections, it may be said that mercury is perhaps the best remedy, since iodide of potassium has been known in some instances to provoke œdema, which is likely to complicate matters.

¹ For further information, especially as to the differential diagnosis of syphilis of the trachea and bronchi, reference may be made to Lancereaux (op. cit., p. 321), and Biermer, Mém. sur les Rétréciss. de la Trachée et des Bronches (Gaz des Hôpitaux, Sept. 9, 1869); two cases, one by Moissenet, the other by Demarquay, where fatal dyspnoea resulted from cicatricial stenosis of the air-passages following the healing of a syphilitic lesion, are given in the Annuaire de la Syphilis, 1858, p. 324, and are quoted by Bumstead and Taylor (op. cit., p. 624).

Astringent and sedative sprays may likewise be employed. Treatment, to be effectual, must be timely and thorough.¹

LUNGS.—Two syphilitic affections of the lungs are commonly described, *diffuse or interstitial pneumonitis*, and *circumscribed or gummatous pneumonitis*. Diffuse pneumonitis may be situated in either the superior, middle, or lower lobes, without, however, invading any considerable portion of tissue. The affected portion of the lung is firm, hard, elastic, friable, impermeable to air, and, consequently, non-crepitant. Circumscribed pneumonitis, which is rather less rare than the diffuse variety, is characterized by the formation of gummy deposits in the lung tissue at one or more points, without any particular locality of predilection. When, however, the gummy tumor is found in the upper lobe, it is at its base rather than at its apex, contrary to what occurs in the case of tubercular deposits. Gummy tumors of the lung are generally firm, smooth, and circumscribed by indurated fibrous tissue; they undergo necrosis at an early date, with fatty or cheesy degeneration beginning at the centre of the nodule. Subsequently absorption may occur, partially or entirely, but more commonly the softened gummatous matter is evacuated by the bronchial passages, leaving a cavity circumscribed by fibrous tissue. Cicatrization may then take place.

The *symptoms* of syphilis of the lung are not characteristic in any way, and the affection is therefore very difficult of recognition. The diagnosis must depend, to a very considerable degree, upon the history of the case and upon the concomitant symptoms. At the same time, there are certain symptoms manifested which may indicate, in a doubtful case, the presence of a syphilitic lesion. For example, a certain degree of dulness on percussion, with a blowing sound and without febrile reaction, the symptom being limited to one of the lower lobes or to the middle lobe, in a cachectic individual the apices of whose lungs are intact while his liver is diseased, constitutes a strong presumption in favor of a syphilitic pulmonary affection. The sudden appearance of abundant sputa, and the seat of alteration being limited in extent, and particularly confined to one side of the thorax alone, are circumstances which likewise aid in the diagnosis. Tuberculous disease of the lung, which is most likely to be confounded with the affection under consideration, is marked not only by a more rapid evolution and more extensive involvement of the organ, but chiefly by making its onset in the apices of the lungs. When, however, the syphilitic lesion happens to occur in the same part, the diagnosis becomes extremely difficult, even to the skilled clinician.

The *prognosis* of lung syphilis is serious, not as much because of the severity of the lesions themselves, as because they are ordinarily accompanied by other visceral lesions, and because they usually occur at an advanced stage of syphilis, when the system is more or less broken down by the disease.

The syphilitic phthisis and asthma of some writers are not, it should be here remarked, independent affections, but are in reality symptoms of the two forms of syphilitic lung disease described, and particularly of the ulceration and stenosis which sometimes occur.

The relationship between syphilis and tuberculosis of the lung has sometimes been the subject of discussion, but although the facts in our possession do not at present war-

¹ See Cohen, *Diseases of the Throat and Nasal Passages*, New York, 1879; and the article on *Injuries and Diseases of the Air-passages* in Vol. V. of the present work. Also Trélat, *De la Trachéotomie dans les Lésions Syphilitiques des Voies Respiratoires* (Gaz. Hebdom., 1869, Nos. 17, 18, et 19).

rant any very positive assertion, yet I think I may safely say that these two affections are never connected together as direct cause and effect. It is true, however, that the cachexia produced by syphilis may favor the deposit of tubercle in the lungs of an individual thus predisposed, and also, on the other hand, it is very possible that the irritation of a diseased lung may predispose to the deposit of syphilitic material, on the principle of the *locus minoris resistentiæ*. There are no facts, however, as yet, to support this latter hypothesis.¹

SYPHILIS OF THE CIRCULATORY SYSTEM.

HEART.—The syphilitic lesions of the heart are of two kinds, diffuse and circumscribed. The former, similar in all respects to diffuse syphilitic myositis, is rarely met with, excepting in connection with the latter (gummatous) form.

The symptoms of syphilitic disease of the heart have not as yet been very exactly made out, because of the small number of cases, and because of the brief period during which these have been under observation. They are of two kinds, functional and physical. Palpitation is almost always present, with irregularity of pulse, and a feeling of weakness. During the latter period of life, severe pain and constriction in the precordial region are observed. There is a certain amount of discoloration (cyanosis) of the face, the lips are slightly cyanosed, and there is a slight degree of œdema. The most marked physical sign is dulness on percussion over the precordial region, and a dull sound, with occasionally a slight murmur accompanying the first sound of the heart, most clearly perceived toward the apex. The veins of the neck and of the extremities are apt to be distended. The progress of the affection is slow, tedious, and insidious.

The *symptoms* of cardiac syphilis are not very strongly differentiated from those of other heart affections. For this reason, in order to make a positive diagnosis, the general affection must usually be recognized. It may be asserted, however, that syphilitic heart affections form a class in themselves which may in very many instances be differentiated from those of a rheumatic character. They usually manifest themselves only by the symptoms of oppression, dyspnoea, irregularity of cardiac action and irregularity of pulse, while the rheumatismal affections which are specially apt to attack the valves of the left heart, particularly the mitral, generally give rise to a well-marked murmur, and are sooner or later accompanied by œdema. Rheumatismal and alcoholic myocarditis, and secondary dilatations of the cardiac cavities, are like the syphilitic lesions in not giving rise to murmurs, and also in causing asystolic symptoms at a certain period. The antecedents of the patient and the presence or absence of cachexia will serve to aid the diagnosis in such cases.²

¹ The following papers may be referred to for fuller details regarding syphilitic disease of the lungs: Gintrac, Phthisie Syphilitique (Gaz. Hebdom., 1877); Hertz, Ein Fall von Aneurysma und Pneumonia syphilitica (Archiv f. path. Anat., 1873, S. 421); Lancereaux, Des Affections Syphilitiques de l'Appareil Respiratoire (Arch. Gén. de Méd., 1873); Id., Note sur un Cas de Syphilis Pulmonaire, suivie de réflexions sur la Syphilis des Viscères et les erreurs dont elle est l'objet (Bull. de l'Acad. de Méd., 2e Série, t. vi. No. 43); Aufrecht, Zwei Fälle von syphilitische miliar Tuberculose (Deutsche Zeitschr. f. prakt. Med., 1874, No. 26); Fournier, De la Phthisie Syphilitique (Gaz. Hebdom., 1875, pp. 758, 773, 802); Thoreson, Syphilis und Phthisis (Norsk Mag. f. Laegevid., 1875, and Schmidt's Jahrbücher, 1875); Rollet, Lungensyphilis (Präger Vierteljahrs., 1877, S. 13, from Wien. med. Presse, 1875, No. 47); Tiffany, Syphilis of the Lung (Am. Jour. Med. Sci., July, 1877, p. 90); also, leading article in reference to discussion in London Pathological Society (Lancet, vol. i., 1877, p. 354).

² See Lancereaux, op. cit., p. 295 et seq.

BLOODVESSELS.—Syphilitic lesions of the veins are so rare as to be practically almost unknown. Gosselin¹ has reported two cases where small gummata were found in the connective tissue of the external covering of the saphenous veins, forming painful cord-like tumors under the skin.

The syphilitic lesions of the arteries are primary or secondary (that is, resulting from lesions in the immediate vicinity). Verneuil, according to Jullien, gives a case of the latter variety, where perforation with excessive hemorrhage resulted from the extension of a phagedenic ulcer. The tissues surrounding the artery and its own coats were involved. Primary syphilitic disease of the arteries is commonest in the smaller vessels of the brain. Pathologically the affection consists in a thickening of the arterial walls by an infiltration of small cells, especially into the tunica intima. The process differs from ordinary atheroma by its most common localization in the smaller arteries; by its more rapid extension, making as much progress in months as atheroma does in years; by its tendency to narrow the calibre of the vessels, while atheroma tends to dilatation with thinning of the vascular walls. Syphilitic lesions of the bloodvessels betray their presence by the trophic visceral affections to which they give occasion. Obliteration of the carotid causes pain in the head, epileptic attacks, and enfeeblement of the cerebral functions, followed by coma and death. In cases where the cerebral arteries, strictly so-called, are involved, severe headache, almost always frontal, worst at night, and joined to various alterations in the psychical functions and those of the organs of sense, shows ischæmia of the brain, and serves as a prodrome of coming mischief. At a later stage an apoplectic attack, with or without loss of consciousness, and more or less loss of motion, or more frequently with aphasia, unilateral paralysis, etc., shows the indirect influence of syphilitic vascular disease. Delirium may also supervene.

The *diagnosis* of syphilitic arteritis must be made with the aid of the patient's history.

The *prognosis* is a matter of grave importance; the question whether syphilis may be a cause of aneurism has for some time engaged attention, and has been at length decided positively in the affirmative.²

SYPHILIS OF THE LYMPHATIC VESSELS AND GANGLIA.

Syphilis may affect the lymphatic vessels and ganglia both in its earlier and later stages. The adenitis accompanying chancre has already been mentioned. It is limited to the vessels and ganglia in the immediate neighborhood of the initial lesion, and as it often lasts until after every trace of the chancre has disappeared, it may at times serve as an important aid to diagnosis in difficult cases.

The adenitis accompanying the early generalized outbreak of syphilitic symptoms appears at various points simultaneously, the glandular engorgement being most marked in the sub-occipital, mastoid, epitrochlear and sub-maxillary regions. Its appearance is contemporaneous with that of the earliest syphilitic eruptions, that is, from the sixth to the twelfth week of the disease. It has been asserted indeed that the glandular engorgement is due to the influence of the eruption, but this is disproved by the fact that it may occur without the presence of any skin manifestation.

The generalized glandular engorgement is very much the same in appearance and symptoms as the localized glandular involvement of chancre. The

¹ According to Jullien, who gives no reference.

² See Wilks and Moxon, *Lectures on Pathological Anatomy*; Lancereaux, *Artérite Syphilitique* (*Gaz. des Hôp.*, No. 21, 1876).

ganglion grows little by little, increasing slowly in size without inflammatory reaction until a pea or filbert-sized tumor is observed, movable, indolent, and disappearing slowly, only perhaps after months. Treatment often fails to quicken its disappearance.

Lymphangitis is sometimes observed in connection with this glandular engorgement. It is more apt to be met with on the inner side of the upper and lower limbs. The vessels appear as cords under the skin, with enlargements at various points.

The late syphilitic affections of the lymphatic glands affect those which are deeply situated. They have only been studied during the past few years. The glands most commonly affected are the abdominal, vertebral, lumbar, iliac, and femoral; then the bronchial and mesenteric glands; lastly those of the limbs.

These lesions are not uncommon in the later periods of syphilis. They are apt to occur in connection with visceral lesions, but they may occur independently. They show no sign during life, and are usually found only on post-mortem examination.

SYPHILIS OF MUSCLES AND TENDONS.

MUSCLES.—I have already, in treating of the general condition of the system before and during the outbreak of generalized symptoms, spoken of the peculiar form of muscular contraction due to the influence of the syphilitic poison.¹ It therefore remains here only to describe the muscular pains of syphilis, and the gummatous tumors of the muscles.

In the early stages of the generalized period of syphilis, certain vague, shifting, rheumatoid pains are observed, seated chiefly about the articulations, or following the course of the muscles and tendons. At a later period, also, somewhat similar pains are noticed at times, involving the muscles, tendons, and fibrous tissues generally. These pains differ, however, from those of the early period of syphilis, in being fixed and persistent, instead of coming and going, now in one place and now in another, like the early lesions. Both the early and the late forms of syphilitic rheumatoid pains are amenable to treatment.

Syphilitic tumor of the muscles has been well described by Bouisson,² who divides the affection into three stages. In the first, the muscle becomes the seat of a perceptible, circumscribed swelling, without pain. The second stage sees the gradual softening of the tumor, the contents of which become a gummy and stringy liquid. Sometimes the tumor, instead of following the ordinary chronic, indolent course, assumes acute symptoms, becomes painful, hot, red, etc., presenting every appearance of an acute abscess. Bouisson thinks that some cases of pelvic abscess, of psoitis, and of inflammation of the iliac muscle, may be referred to this disorder. In the third stage, the tumor no longer softens, but becomes of an almost cartilaginous hardness, and even bony. These muscular ossifications may occasionally be accompanied by exostoses.

The tumors under consideration may be observed in the muscles of the thigh or calf, in the trapezius, sterno-mastoid, pectoralis major, etc. They are commonest, however, in the tongue, though they may be met with anywhere. Occurring in the larynx, they may be mistaken for laryngeal phthisis.

¹ See p. 487. In addition to the references there given the following may be mentioned: Notta, *Sur la Retraction Musculaire Syphilitique*. Archives Gén. de Méd., Déc. 1856.

² Arch. Gén. de Méd., Déc. 1850.

As already mentioned, bony transformation is the occasional result of muscular syphilis.

The course of this affection is slow and insidious. Very often the patient himself is not aware of its existence even after it has lasted a considerable time. The pains which are frequently experienced in the earlier stages of the disease, are apt to be considered rheumatic. Afterwards, in the case of gummata, when the tumor softens it is taken for an abscess. I have seen this mistake made repeatedly, and have had patients present themselves with gummata of the muscles which had been treated with poultices for a considerable period, without the true nature of the lesion having been suspected.

As a rule, syphilis of the muscles tends to get well under appropriate treatment. The diffuse form, however, may result in atrophy or destruction of some of the muscular fibre, and thus lead to permanent retraction.

The diagnosis of the syphilitic lesions of the muscles is not difficult when the concomitant symptoms, usually among the later manifestations, are taken into account. Abscess and cancer, for which the softened gummatous lesions are occasionally mistaken, may be distinguished by the characteristics pointed out under gummata of the skin.

TENDONS.—The syphilitic affections of the tendons resemble closely those of the muscles. They consist either in a partial thickening, or in the presence of small gummatous nodes in the structure of the cord-like tendons, or of the membranous aponeuroses.

Those tendons which are most thick and firm are most frequently attacked. The tendo Achillis and the tendons of the femoral biceps and quadriceps are most apt to be the seat of the affection. Nélaton observed two gummy tumors developed in the latter tendon which simulated a foreign body in the knee. In another case the tumor, which occupied the rectus muscle of the thigh, became the point of departure for a hydrarthrosis, which might easily have been mistaken for a white swelling.¹

The syphilitic affections of the aponeuroses are not usually painful. Those situated in the tendons of muscles give rise to pain when the muscle is used, sometimes to a greater or less extent preventing movement. Usually subcutaneous, these lesions show themselves at first as abrupt, sharply-defined, hard, small nodules. At a later period they soften, the skin covering them becomes red and inflamed, and ulceration sets in, giving exit to the softened gummatous product, which, it must be noted, is not purulent, but is thin and colorless, or slightly tinged with blood. The ulcers thus formed are slow to heal, but finally they get well without retraction having taken place in the tendon. After suppuration has occurred, it is not difficult to make the diagnosis, but in the earlier stages of syphilitic disease of the tendons, it is often difficult to distinguish the lesions from the ordinary "ganglions" found in the same localities. They are reducible, however, under appropriate treatment, and also run a very different course. Neuromata, which may sometimes be confounded with syphilitic lesions of the tendons, are painful, and their seat also is usually different.²

The prognosis of these affections is favorable. They do not lead to any permanent injury of the parts affected.

¹ Saint-Arroman, Thèse de Paris, 1858.

² See Notta, Recherches sur une affection particulière des Gâines Tendineuses de la Main, caractérisée par le développement d'une nodosité sur le Tendon des Fléchisseurs des Doigts. Arch. Gén. de Méd., t. xxiv., 4e sér., p. 142.

SYPHILIS OF PERIOSTEUM AND BONE.

Lesions of the periosteum and bones are frequent in syphilis. Formerly they were supposed to belong only to the later stages of the disease, but they are now known to occur quite early, in some cases being coincident with the papular syphilodermata.¹

OSTEOCOPIC PAINS.—The name "osteocopic" (see page 375) has been given to certain painful sensations observed in the bones, not merely in syphilis, but in other affections. However, as they are much the most commonly met with in syphilitic patients, the name has come to be associated exclusively with the idea of syphilis, particularly with the later periods of the disease.

These pains occur spontaneously; they are aggravated by pressure and are commonly found in the more superficial bones, such as those of the cranium, the tibia, clavicle, radius and ulna, sternum, etc.; their constancy distinguishes them from the more wandering pains of rheumatism. One of the most marked characteristics of the osteocopic pains of syphilis is that they acquire their maximum intensity toward midnight or one o'clock in the morning. Ricord said that this was due to the warmth of the bed, and asserted that individuals, such as bakers, whose occupation required them to turn day into night, experienced osteocopic pains when they went to bed, that is in the daytime. This explanation, however, does not fit all cases, since in many instances the pains return at a given hour, whether the persons are in bed or not.

The pains are at first moderate, but gradually become more severe, and are occasionally so excruciating as to wring cries of pain from the sufferer. In some cases they are the only sign of the disease, but more frequently are merely the indication and symptom of a material affection of the bone. It is not unusual for osteocopic pains to fix themselves at some particular point in a bone, and for periostosis or exostosis to be subsequently observed in the same situation.

Although commonly occurring at a late period in the evolution of syphilis, these pains may be felt at any, even a very early stage. From the rheumatic pains of syphilis, the osteocopic pains are distinguished not only by their fixity, as before mentioned, but by being aggravated by pressure. The rheumatic pains are wandering, and are unaffected by pressure.

DIFFUSE GUMMATOUS INFILTRATION.—This form of syphilitic bone disease² is characterized by a more or less general deposit of gummy matter, diffused through the deep or superficial portions of the bone substance. This is soon followed by absorptive action, which, when influenced by treatment, may lead to the disappearance of the syphilitic deposit, or, left alone, may result in the death and separation of a sequestrum of bone. Sometimes the affection takes a different line of action, and, instead of causing destruction of a portion of the bone, leads to the throwing out of new osseous tissue. In the body of the bone this process is called *osteitis condensans*; on the surface it gives rise to *osteophytes* and *exostoses*.

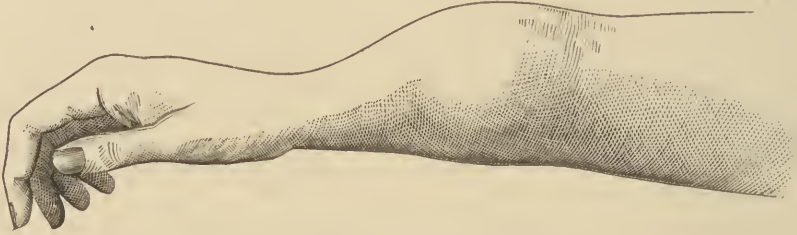
Productive osteitis is a constant accompaniment of neoplastic action, occurring in the immediate neighborhood of the neoplastic points, and as a consequence of irritative action of moderate intensity. As a result of this

¹ See Mauriac, *Mémoire sur les Affections Syphilitiques Précoces du Système Osseux*. Paris, 1872.

² I have followed Jullien (*Traité Prat. des Mal. Vénér.*), in this description of the bone lesions of acquired syphilis.

productive inflammatory action, the lacunæ and cavities left by the breaking down of the syphilitic deposit are filled up with new material, the normal density of the bone being by this means again restored or even surpassed. In the latter case eburnation begins, the Haversian canals are closed, and hyperostosis may take place, reaching occasionally such a degree that, in the skull, the bones may be nearly an inch thick. When this process goes a step further, nutrition is interfered with, and the affected portion of bone dies and is thrown off as an eburnated sequestrum.

Fig. 335.



Periostosis (node) of bones of forearm due to hereditary syphilis.

When superficial, the new formation arises from the periosteum, or at least from its medullary layer, and is therefore sometimes called *periostosis*. (Fig. 335.) The tibia is the commonest seat of this diffuse form of syphilitic bone disease. One form of periostosis, that in which the new bony deposit adheres rather loosely to the body of the bone, is called *epiphyscal exostosis*. Cellular at first, this deposit becomes in time compacted by the deposit of new lamellæ about the original trabeculæ, so as to lead even to eburnation.

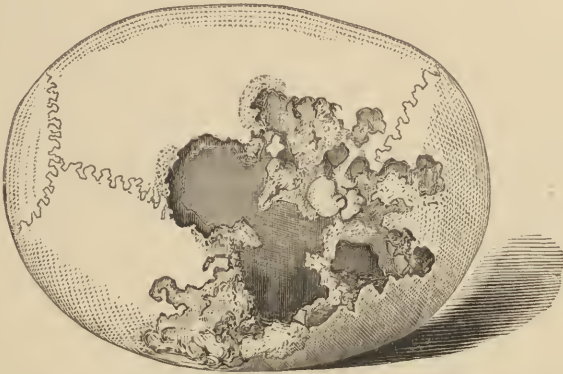
On the other hand, the exostosis is called *parenchymatous* when the tumor, though visible externally, is the consequence of an osseous deposit in the thickness of the bone itself.

CIRCUMSCRIBED GUMMATOUS INFILTRATION.—On the surface of the bone, the gumma presents the appearance of a sharply circumscribed lesion. It has been chiefly studied in the form in which it appears upon the cranium. The substance of the lesion, gelatinous in appearance, accumulates between the bone and the dura mater on one side, or between the bone and the periosteum on the other, and penetrates the osseous substance like a wedge, causing its progressive absorption. When two gummata happen to occur opposite one another, and to meet in the diploic structure, perforation is the result. (See Fig. 336.) Under treatment, circumscribed gummata of the bones gradually undergo lardaceous or caseous metamorphosis, and are absorbed, leaving, however, a depressed stellar cicatrix, rendered more conspicuous by the plastic deposits about the periphery caused by the irritation. Virchow considers this the result of a process to which he has given the name *dry caries*, but in the opinion of some other syphilographers the gummatous process is sufficient to account for the appearances presented.

The evolution of the gumma, as this takes place in the interior of the bones, particularly of the long bones, is not very well understood. Ricord's plates, however, show that the lesion may occupy the medullary cavity, where it presents the appearance of a lardaceous mass around which the compact tissue is redder and more porous. Occurring in the substance of the spongy

tissue of the ends of the long bones of the hand and foot, especially in very young children, the gumma may often assume the appearance of *spina ventosa*.

Fig. 336.



Necrosis of cranium with loss of entire thickness of bone, in places, following gummatous disease. (From a specimen in the Mütter Museum, College of Physicians of Philadelphia.)

The compact tissue and the periosteum, forced outwards, distend like a globe of molten glass at the breath of the glass-blower, and form a shell with extremely

Fig. 337.



Hereditary syphilitic disease of bones of hand. (Dactylitis syphilitica.)

thinned walls, as shown in Fig. 337, which represents a case occurring in a young colored girl under my care at the University Hospital. This lesion of

slow evolution disappears, under prompt treatment, by resorption of the neoplasm, leaving no trace of its former presence. Left alone, it may lead to serious disfigurement.

As has been observed, necrosis is a not unfrequent result of gummatous affections of the bones. Suppuration, phlegmonous swellings, openings with everted edges, fistule, loss of substance in the skin, etc., are among the visible results of syphilitic necrosis, not differing, however, in this respect from the effects of other forms of necrosis. Sometimes a sequestrum is surrounded and inlaid as it were in the hypertrophied superjacent tissues, as in a portion of eburnated bone surrounding it. Syphilitic necrosis may extend by the formation of new gummatous deposits, giving the edge of necrosed bone a peculiar "polycyclic" appearance, which is quite characteristic and most apt to be observed in the skull (Fig. 338).

Fig. 338.



Necrosis of cranium following circumscribed gummatous disease. (From a specimen in the Mütter Museum, College of Physicians of Philadelphia.)

An absurd superstition still prevails among the ignorant regarding the influence of mercury in causing bone troubles. It is hardly necessary to say that this is entirely without foundation. On the one hand, abundant statistics exist to show that untreated syphilis is more likely to show bone disease; and, on the other hand, it has been found that miners and workers in mercury are not any more subject to osseous affections than other persons.

The following tables from Jullien show the comparative frequency of the various syphilitic bone affections and their commoner localization:—

COMPARATIVE FREQUENCY OF VARIOUS FORMS OF SYPHILITIC BONE DISEASE.

(Jullien).

Osteitis and osteo-periostitis	.	.	.	12 cases
Circumscribed gummata	.	.	.	11 "
Necrosis (elimination of bone)	.	.	.	20 "
Exostosis	.	.	.	15 "
Periostosis	.	.	.	7 "

Locality of the above lesions.

Nose	19 cases
Tibia	15 "
Palate	15 "
Sternum	5 "
Clavicle, maxillary, each	2 "
Frontal	2 "
Parietal, vertebra, each	1 case
Scapula, ulna, radius, each	1 "

SYPHILIS OF THE CERVICAL VERTEBRÆ.—When the lesion is seated in the body of a vertebra, towards its anterior aspect, it forms a tumor in the pharynx. Together with difficulty of deglutition, which may even amount to danger of suffocation if too large a bolus of food is ingested, there are pain, chiefly nocturnal in character, difficulty of motion, and the characteristic attitude of cervical ankylosis. Death from inanition or dyspnoea may result if the tumor does not soften and break down into a pharyngeal abscess. The prognosis is even graver when the lesion is seated in the medullary cavity. The symptoms of compression, paralysis, or irritation of the spinal cord are very difficult of diagnosis, their cause, if not their nature, remaining obscure. If the lesion is confined to the transverse apophyses, some of the spinal nerves may be compressed, giving rise to difficulties of function, etc., according to the nerve pressed upon.¹

SYPHILIS OF THE CRANIUM.—The headache which accompanies the appearance of gummata of the cranium, is so severe that it often leads to the suspicion of deeper lesions. The patient is driven almost frantic by the pain of the bone lesion combined with that of direct pressure upon the cranium. Circumscribed gummata appear as slowly growing tumors on the forehead, temples, etc., and may attain considerable size, having hard, raised borders of bony tissue, the result of the productive osteitis caused by the irritative influence of the tumors. These tumors have little tendency to ulceration; they disappear very rapidly under the influence of iodide of potassium, but the bony growth around them, if well formed, remains. Relapse, however, takes place with great facility; the swelling begins to increase again as soon as the iodide of potassium is stopped, and these tumors may thus come and go for years.

Diffuse gummatus infiltration of the cranial bones may lead to extensive ulceration and loss of substance, with denudation of the dura mater, and occasionally modification in the form of the cranium, through contraction following the absorption of bony tissue (see Fig. 336).

Surgical interference in these cases should be undertaken only with great caution. When, however, a sequestrum keeps up irritation by its presence, its removal is justifiable and desirable. Iodide of potassium should be persistently administered in the mean time.

SYPHILIS OF THE BONES OF THE ORBIT.—The recognition of these lesions is extremely difficult, especially when the symptoms are not marked, being limited perhaps to slight œdema of the eyelids with local pain. Under these circumstances simple neuralgia is often diagnosticated, and quinine is administered to the detriment of the patient. This mistake may be avoided by taking note of the nocturnal character of the pain, and by exploring the interior of the orbit with the index finger, as far as possible, when increasing

¹ For a striking case of involvement of the lower dorsal or lumbar vertebræ, see Fournier, *Cas du maladie de Pott d'origine syphilitique*. *Ann. de Derm. et de Syph.*, n. s. t. ii. p. 19

tenderness of the periosteum will be observed. When the upper lid is much swollen, the eyeball projecting, and the orbital periosteum elevated, the history will generally confirm the suspicion of syphilitic disease thus aroused, and the result of treatment will confirm the diagnosis.

SYPHILIS OF THE MAXILLARY, PALATE, AND NASAL BONES.—The maxillæ are not unfrequently attacked, usually in the superior alveolar processes. The teeth loosen, the gums become red and swollen, and ulcers appear, which pour out a peculiarly nauseating discharge. The fetor of the breath, and the difficulty of speech, mastication, and deglutition, make this affection most painful and disagreeable to the patient and to those around him. Serious deformities often result from the loss of portions of the maxillæ, teeth, etc., but these can almost always be remedied by artificial appliances.¹

When the palate is attacked, the disease may be so insidious in its onset as to show no sign until perforation is on the point of taking place. Fortunately, if only a small portion of bone is thrown off, advantage may be taken of the tendency of the soft parts to heal and cover the deformity, and by judicious stimulation the granulating edges may sometimes be made to join and afford membranous occlusion to the nasal passages. Occasionally, however, the gummatous growth penetrates with great rapidity, involving the palate and bones of the nose, and resisting all treatment until the bones are largely destroyed and until hideous deformity results.

When syphilis attacks the nasal bones, it is usually at first localized in the septum. Severe osteocopic pains may accompany the appearance of the lesion, these, together with coryza, nasal tone of voice, muco-purulent discharge, ozæna, and elimination of bits of bone, being among the first symptoms of the disease. Necrosis of the various bones of the nose, with flattening of the bridge, is a common effect of syphilis, the vomer, however, usually remaining intact.

The treatment of syphilis of the nasal bones should be prompt and thorough. In addition to the use of iodide of potassium internally, frequent disinfectant injections are to be employed, such as dilute liquor sod. chlorinat., solutions of salicylic acid or chloral (5 gr. to fʒj), etc.

SYPHILITIC DACTYLITIS.—Under this designation Dr. R. W. Taylor, of New York, described in 1871² a rare affection of the fingers and toes which had previously been alluded to by one or two writers, but which had never been fully studied. The affection is caused by both hereditary and acquired syphilis, the latter form, that under consideration, being much the more rare, and less than twenty-four cases having been recorded. There are two varieties: (1) that in which the subcutaneous connective tissue and the fibrous structures of the joints are involved; and (2) that in which the morbid process begins in the bones and periosteum, secondarily implicating the joints, and perhaps accompanied by deposit in the subdermal connective tissues.

The lesion develops slowly, the affected member gradually increasing in size, and becoming hard and firm. When the toes are affected, they are swollen uniformly throughout their entire length, but in the fingers a single phalanx is apt to be attacked, almost invariably the proximal one. The affected member is reddish or violaceous in color, and is firm to the touch, resistant, and tense. The swelling is usually developed painlessly, but there is sometimes a dull aching sensation. The periosteum is affected in this form

¹ See Jullien, *op. cit.*, p. 875; also works on operative dentistry.

² *Am. Journ. Syph. and Derm.*, vol. ii., 1871, p. 1. See also Wigglesworth, *Case of Dactylitis Syphilitica*, *Amer. Journ. Syph. and Derm.*, vol. iii., 1873, p. 142.

of dactylitis, but the bone is implicated very slightly if at all. The joints are involved within a few weeks after the development of the affection, the movements, at first hindered by the swelling and infiltration of the soft parts, becoming unnaturally free. Sometimes there are slight hydrarthrosis and crepitation in the joint. A single finger or toe, or several, may be involved, or one or both hands or feet, one toe being attacked after another, or several simultaneously. The disease runs a chronic course. There is no tendency to ulceration. There is generally complete restoration to the normal condition if treatment is instituted in good time. In neglected cases, however, the joints may be rendered permanently useless, and the bones may remain enlarged.

The second form of syphilitic dactylitis is sharply limited to the bone, and is due to either periostitis or osteo-mylitis. The affection may progress rapidly, slowly, or with intermissions. The earlier after infection that the lesion occurs, the more acute is its course. Usually a single phalanx, the proximal most commonly, is affected, becoming greatly swollen, assuming an acorn or balloon shape, and being hard and tense, while the superjacent integument remains unchanged, or smooth and red if the process has gone on rapidly. More than one phalanx may be affected, or several fingers or toes, on one or both hands or feet. The hands are the more usually attacked.

The joint structures are usually much thickened. After the dactylitis has lasted for about a month, the surgeon may detect crepitation from friction of the articular surfaces, the result of erosion due to impaired nutrition. Motion of the joints may be diminished or may be unnaturally free.

These bony swellings are very indolent. The gummy material may be gradually absorbed after a time, or it may soften and be discharged through a sinus, while the bone itself may be permanently altered in size and shape, and the function of the finger greatly impaired. There is little or no pain.

The affection is one of the late manifestations of syphilis, commonly occurring between the fifth and fifteenth years. Exceptionally it appears early, one case having occurred in the eighteenth month after infection.

The early recognition of both forms of dactylitis is a matter of great importance, as early and efficient treatment is necessary to prevent permanent deformity. The subcutaneous variety in its early stage might be mistaken for paronychia, but the absence of acute inflammatory symptoms, especially pain, establishes the diagnosis. The subacute character of dactylitis will also serve to distinguish it from gout. When several joints are attacked, rheumatoid arthritis might be suspected, but here also are acute inflammatory symptoms and pain, which are absent in dactylitis. The two affections do not attack the phalanges in the same manner, and dactylitis early tends to characteristic deformity. Enchondromata or exostoses, which might be mistaken for dactylitis, show more localized swellings, limited to a portion of the circumference of the bone. The prognosis of dactylitis is favorable if early "mixed" treatment is employed. Pressure with mercurial plaster spread on chamois skin is sometimes beneficial.

SYPHILIS OF THE ARTICULATIONS.

The study of syphilitic arthritis was first entered upon by Richet in his classical monograph published in 1853,¹ but the knowledge of the subject has been increased since then by the publication of several papers by Lancereaux and others.

¹ *Mémoire sur les tumeurs blanches.*

Syphilitic arthritis is a very late lesion of syphilis, often following ten, twelve, or even twenty years after infection, and differing from the early joint affections in this point, among others, namely, that it is commonly confined to a single articulation. The knee-joint, and especially the left, is the commonest seat of the affection; less frequently the wrist, elbow, ankle, temporo-maxillary articulation, hip, etc., are affected.

Pathologically, syphilitic arthritis originates either in lesions of the synovial and fibrous tissues, or in lesions of the bones and periosteum. As it presents itself in the sub-synovial cellular tissue and in that of the capsule, the syphilitic lesion takes the form of small, yellowish, dry, elastic, rather soft masses. A secondary lesion is erosion of the cartilages, due in all probability to the fact that the synovial and fibrous tissues upon which they depend for nutrition are diseased. There is almost always effusion into the affected joint. In one case where an examination was made, the effused fluid proved to be thick, stringy, cloudy, and very fibrinous. Under the microscope the fluid was seen to contain amorphous globules, epithelial cells, and altered blood globules, contained in an abundant albuminous mesh-work.

The bone lesions which occur in connection with syphilitic articular disease take the form of swellings—uniform hyperostoses of the spongy portions of the bones, due to a more or less intense osteo-periostitis. It is rare that the entire articulating surface is altered, the disease being usually confined to a circumscribed portion.

In Jullien's opinion, late synovitis may occur as a remote result of early syphilitic troubles in the joint. In any event the affection begins slowly and insidiously, and is at first unrecognized. After a time, a certain stiffness or tension is observed in the joint; then effusion takes place. The intermittent disappearance and reappearance of the congestive symptoms which give rise to this hydrarthrosis are among the surest signs of the syphilitic nature of a given case. Palpation reveals in some instances the existence of sclerosed patches in the synoviæ—small, soft, rounded gummata of the periarticular tissues. Besides these, all the ordinary signs of hydrarthrosis are present. In addition, there is very little reaction, and hardly any pain, either spontaneous or aroused by pressure, or by the movements of examination. If in addition to these symptoms there are general signs of syphilis, and if the disease yields quickly to specific treatment even although it may have lasted for some time, the case is certainly one of syphilitic arthritis.

Although facts are wanting to prove the proposition, yet it is safe to say that the synovial form of syphilitic arthritis is benign, and without tendency to ulceration or suppuration.

The osseous variety, however, is more serious. It may appear suddenly with severe pain, generalized at first over the joint, but soon concentrating itself. At times this may be excessive, but usually it is not extreme, and it comes on at night to disappear with the morning. The diagnosis will be based on an examination of the osseous extremities; the roughnesses, the nodes of which they are the seat; not less than their enlargement, are characteristic. Occasionally some elongation of one of the bones entering into a joint takes place. The effusion about the joint is less marked than in the other form of arthritis, unless when both forms exist together, which is not rare. It is generally necessary to immobilize the affected limb in this form of syphilitic arthritis, and unless heroic antisyphilitic treatment is employed, serious deformity may result.

The usual treatment of syphilitic arthritis is the administration of iodide of potassium in large doses, that is, from half a drachm to a drachm and a half daily. To this mercury may be added, and in many cases general tonics are also required. Locally, strapping may be resorted to with the emplastrum de

Vigo, or emplastrum ammoniaci cum hydrargyro, with which I have sometimes advantageously combined graduated compression by means of the rubber bandage. Large blisters subsequently dressed with mercurial ointment are useful. In cases where considerable effusion has taken place, aspiratory puncture is recommended by Jullien.

SYPHILIS OF THE BURSÆ.

Keyes, of New York,¹ designates as tertiary bursitis a late lesion which is apt to follow after injury. The bursæ of the knee are most apt to be involved, and the affection is very often double. The lesion is essentially a gummatus proliferation in the thickened parietes of the serous sacs. The affection begins insidiously, and is usually unaccompanied by pain, sometimes lasting thus for months, when a blow or a fall brings on acute inflammation, the lesion takes on new action, and extensive ulceration may take place.

The "mixed treatment" rapidly heals these lesions, without a scar if they are of the superficial variety, but with a cicatrix if deep ulcerative action has taken place.²

SYPHILIS OF THE NERVOUS SYSTEM.

The greater part of our knowledge of the syphilitic affections of the nervous system is of recent date, and has been acquired within the last twenty years. In 1859, the Academy of Medicine of Paris offered the subject of "Nervous affections due to the syphilitic diathesis" for competition. In response, three remarkable monographs,³ which marked an epoch in the progress of this branch of medicine, made their appearance, and are still to be referred to with advantage on account of the valuable clinical material which they contain. Ever since that time the medical press has been sending out papers, monographs, volumes even, on nervous syphilis, in constantly increasing numbers, until the literature of the subject has become extremely voluminous.

It is obviously impossible, within the limits of the present article, to give an extended account of the various lesions and symptoms of syphilis of the nervous system. The utmost which can be accomplished is to give a general idea of the subject, and to refer the student to original sources for further information.

Syphilitic nervous affections may be developed as early as the sixth month,⁴

¹ Syphilis as affecting the Bursæ (with a wood-cut). *Am. Jour. Med. Sci.*, 1876.

² The following monographs and papers on syphilis of the bones, articulations, and bursæ, may be referred to for further information. "Improved Forms of Artificial Noses" (*Brit. Med. Jour.* 1868); Sigmund, Zur örtlichen Behandlung syphilitischen Mund, Nasen und Rachen Affectionen (*Centralblatt*, 1870, S. 653); Hutchinson, Syphilitic Caries of the Cranium with Abscess of the Brain (*Lancet*, Dec. 14, 1872); Cuffer, Fracture presque spontanée du fémur droit consécutive à un Ostéo-sarcome chez une Syphilitique (*Bull. et Mém. de la Soc. Anat.*, Fév. 1874); "Dental Syphilis" (*Lancet*, vol. i. p. 674, 1876); R. W. Taylor, Bone Syphilis in Children, New York, 1876; Richet. Mémoire sur les Tumeurs Blanches (*Mém. de l'Acad. de Méd.*, t. xvii, 1853); R. W. Taylor, Two Cases of Syphilitic Synovitis of the Knee (*Am. Jour. Syph. and Derm.*, April, 1871); Verneuil, Lésions Syphilitiques Tertiaires des Bourses Sous-cutanées et Tendineuses (*Gaz. Hebdom.*, 1873); Moreau, Affections Syphilitiques des Bourses Séreuses (*Thèse de Paris*, 1870); Weil, Syphilitische Gelenkrankheiten (*Centralbl. f. Chir.* 1877, S. 329); Wigglesworth, Cases of Dactylitis Syphilitica (*Am. Jour. Syph. and Derm.*, 1872, No. 21).

³ Gros et Lancereaux, Des Affections Nerveuses Syphilitiques. Paris, 1861; Lagneau *fils*, Maladies Syphilitiques du Système Nerveux. Paris, 1860; Zambaco, Des Affections Nerveuses Syphilitiques. Paris, 1861.

⁴ See Fournier, Leçons sur la Syphilis, 2e éd., for a full clinical description of the earliest nervous disturbances of syphilis.

and as late as the twentieth year after infection. They are found more commonly among men than among women, and are apt to occur between the ages of twenty and thirty, chiefly because syphilis is most apt to be contracted at this period of life. It is said by some authorities that nervous symptoms are more apt to show themselves in cases where the earlier manifestations of syphilis have been mild, while others hold the opposite view, and consider severe early symptoms the forerunners of nervous disease. In my opinion, no prognosis can be made in any given case by observation of the early manifestations.

The nervous tissue is not usually attacked primarily, but as the result of lesions in the surrounding or investing structures. For instance, lesions of the meninges, or of the bones, induce softening or induration of the brain. A characteristic of the nervous lesions of syphilis is that they are peculiar in their distribution, and may occur in several places at once, thus giving rise to irregular and incongruous symptoms.

Nervous symptoms of a syphilitic character are peculiarly liable to occur in individuals of a neurotic or neuropathic constitution, hereditary or acquired. Mental anxiety, depressing emotions, sexual excesses, the abuse of alcohol and of narcotics, are among the known predisposing causes. Diseases accompanied by cerebral congestion, malaria and other conditions producing cachexia, may act indirectly. Sunstroke and injuries to the skull may also be included among the predisposing causes.

PATHOLOGICAL ANATOMY.—*Lesions of the Cranial Meninges.*—Meningitis may result primarily from syphilitic disease in the structure of the meninges, or secondarily from syphilitic lesions of the cranial bones. The first variety alone is at present to be considered. Either of the membranes may be affected singly, or all together. The lesions may be gummatous in character, or they may consist in diffuse infiltrations accompanied or not by inflammation, or inflammation alone may occur.

Lesions of the Encephalon.—Gummata of the brain present themselves in the form of irregular, variously-sized, firm tumors. These are almost invariably situated at or near the surface. Sometimes they occur in considerable numbers, and disseminated in different parts of the brain, thus giving rise, as has been remarked above, to various and confusing symptoms. As to size, gummata of the brain are rarely larger than a hen's egg, or smaller than a pea. Miliary gummata of the brain are rarely or never met with. The most common seats of gummata are the convex surfaces of the hemispheres in the frontal region, the base of the brain near the pituitary body, and the pons Varolii. The first of these localizations explains the frequency of aphasia in syphilitic brain affections, while the latter accounts for the coexistence of trifacial neuralgia and paralysis of the motor nerves of the eye, this last being an almost pathognomonic symptom of brain syphilis.

Gummata of the *cerebellum* are very rare. Only a few cases have been reported; these presented symptoms of motor incoördination, etc.

Lesions of the Spinal Meninges and of the Cord.—Lesions of the spinal meninges are almost always secondary, and due to exostoses of the vertebral walls. They are very rare as primary lesions, although such cases have been reported by Wilks, Winge and Charcot, and Gombault. In some of these cases the cord was also involved, gummata being found in its substance.

Lesions of the Nerves.—As has been said, the nerves are not usually attacked primarily by syphilitic disease, their troubles generally arising from pressure and atrophy, which interfere with their functions. Tumors of the nerves proper have, however, been reported by Esmarch and Jespersen, Dixon, Portal, and Delafield. Petroff asserts that the sympathetic is attacked,

but corroborative evidence of this has not as yet been brought forward by other observers.

SYMPTOMATOLOGY.¹—*Headache* is met with in about one-third of all cases of syphilitic brain disease. The pain is different from that experienced in early cephalic periostitis; it is deep-seated, and is felt to be so by the patient. In some cases it may last for several months without being at any time excessive; it is dull and heavy, and the patient is able to go about his ordinary occupations in spite of it. Occasionally, however, the sensation of pain is excessive; the older writers exhausted language in the attempt to express its intensity and character. Sometimes there is a sense of constriction, as if the head were being squeezed in a vise; sometimes it feels as if it were being hammered; at other times the patient feels as if a ball of fire were rolling about within his skull. Delirium, acute and even suicidal, and heavy stupor, physical and mental, are sometimes experienced. Nocturnal exacerbation is characteristic of this as of other syphilitic affections, the exceptions being rare.

Another characteristic is the long persistence of the pain where medication has not been employed. Cases have been reported in which the pain had persisted for ten and even twenty-five years, and it is not infrequent to see cases where the head-trouble has resisted the entire arsenal of anti-neuralgic remedies for months, to yield in twenty-four hours to anti-syphilitic medication.

The seat of this form of headache is, in seven cases out of ten, frontal or temporal; the posterior portions of the cranium are rarely affected. The pain is diffuse, and not local.

Absent, as has been said, in a considerable number of cases, headache is, when present, an early and a very important prodromic symptom—a call for immediate therapeutic aid to avert almost certainly appending disaster. Unfortunately, however, it is a symptom too often overlooked, ignored, or misunderstood.

Paralysis.—Sensation and motion may be abolished in any portion of the body by the action of the syphilitic poison, but one of the marked characteristics of affections of this nature is their partial and often incomplete character. They often succeed convulsive symptoms, aphasia or cephalalgia, and may occur at a very early stage in the syphilitic disease, showing themselves as paralyses of the cranial nerves.

Paralysis of Sensory Nerves.—Abolition of *olfaction* is sometimes observed; it is commonly, if not always, a sign of intra-cranial disease. The invasion of the affection is very slow and deliberate, and it yields readily to anti-syphilitic treatment. In many patients olfaction is only lost on one side.

Anosmia may be due to a lesion of the seventh or of the fifth pair. In case of paralysis of the facial, the muscles of the corresponding nostril become immobile, and present a mechanical obstacle to the perception of odors. When the nasal or superior maxillary nerves are affected, the mucous membrane of the nasal fossæ may suffer an impairment of nutrition, which may put an entire stop to the performance of the olfactory functions.

Abolition of the *sense of taste* has been reported.

Vision may be interfered with by lesions about the roots of the optic nerves.²

Clinically, the loss of vision, occurring suddenly or gradually, accompanied by subjective sensations (musæ volitantes, blue or red sparks, or circles of

¹ I have borrowed largely from Jullien in the present and previous parts of this section.

² For a detailed description of these syphilitic nervous eye affections, see Jullien, *op. cit.*, p. 950.

fire), is often only partial. The patient can only distinguish a part of a single object, or of two objects sees but one. Another only sees the top and bottom of some object in front of him, the middle part remaining invisible. In some cases of amaurosis, the first effect of treatment is to make the blindness partial merely. A case is on record where the perception of one color after another was successively restored.

A singular and, as yet, inexplicable intermittence, regular or irregular, has been noted in some cases. In one instance, loss of vision occurred daily between twelve and two, preceded by a severe frontal headache. The attack usually lasted from a quarter to half an hour, and was repeated several times.

The prognosis of these eye-troubles depends upon their early recognition and treatment by means of iodide of potassium. When the tissues are secondarily involved (atrophied by pressure, etc.), it is too late to expect much advantage from treatment.

Hearing.—Various disturbances of audition may occur, due to neoplasms situated in the neighborhood of the auditory centres and of the eighth pair of nerves, either along their course or in their intra-bulbar portion. Very frequently the deafness of nervous syphilis is preceded by a period of excitation, characterized by auditory hyperæsthesia, or by the production of various subjective sensations. It is hardly necessary to say that this ear-trouble of central origin, characterized as it is by want of regularity, its occasional intermittence, and its curability, should be carefully distinguished from that variety of continuous deafness which is brought about by local syphilitic affections of the auditory apparatus.

Paralysis of the Motor Nerves of the Eye.—The three motor nerves of the eye, passing as they do for some distance along a bony canal, and in a portion of the cranium peculiarly subject to the late lesions of syphilis, are very apt to be affected by the pressure of some neoplasm, or some inflammatory swelling of the periosteum, at one point or another. In fact, a sudden and unexpected paralysis of these nerves may be said to be an almost sure sign of the existence of syphilitic disease, even when no other exists.

The *motor oculi*, the *motor externus*, and the *patheticus* may be weakened or paralyzed either singly or together, one or two branches on the right side being sometimes affected at the same time that other branches on the left side are similarly involved. Also, the degree to which the nerves are affected varies in different cases, and occasionally at different times in the same case, a circumstance which often makes the diagnosis quite difficult. In examining a case, careful analysis must be made of the muscles affected, and then, by referring to the nerves supplying these muscles and collating the facts observed, the lesion may often be located. These, like the other syphilitic affections, are very variable from one time to another, and also, it may be added, are usually very amenable to timely treatment by specific remedies.

Hemiplegia.—The hemiplegia of syphilis has been particularly studied by Van Buren and Keyes.¹ It is characterized by occurring at an earlier age than other forms of hemiplegia, eighty per cent. of the reported cases having occurred before the age of forty, while forty-six per cent. only of apoplectic hemiplegias occur before the same age. Another characteristic of syphilitic hemiplegia is the coincidence of fixed and persistent headache, which is an invariable symptom. Other diagnostic points are, the occurrence of the hemiplegia without loss of consciousness, and the concomitant existence of other syphilitic lesions, particularly dilatation of the pupil, showing either in the eye on the hemiplegic side or on the other, without paralysis of the motor oculi.

¹ Syphilis of the Nervous System, N. Y. Med. Journ., Nov. 1870.

Paraplegia is a rare syphilitic nervous affection. It is usually brought about by direct or indirect lesions of the cord or its membranes. Sometimes it is due to a neoplasm involving the cerebral motor centres. Cases of acute myelitis with paraplegia occurring in syphilitic subjects, and supposed to be due to the syphilitic disease in its early period, have been reported by Mauriac and others.

Among the more prominent features of syphilitic paraplegia the following may be mentioned. Contrary to what occurs in hemiplegia, where vesical contractility is always intact, dysuria is often one of the earliest symptoms. The patient expels his urine with difficulty, and often fancies that he is suffering with urethral stricture. Imperfect erection with premature expulsion of the semen on attempting copulation is likewise common. The affection runs a rapid course, soon reaching its full development, and then remaining unchanged for a long time, sometimes indefinitely; it is rare, however, to observe complete palsy of the lower limbs; commonly there is nothing more than a difficulty of movement—paresis. Among the most important concomitant symptoms, from a diagnostic point of view, are headache and backache—*rachialgia*—very frequent and very significant signs of the syphilitic affection, above all when they occur or become aggravated at night.

Syphilitic paraplegia is by no means the mild affection it has sometimes been represented. Although mercury and iodide of potassium often have a marvellous influence upon it,¹ and indeed are the true criteria of diagnosis, they by no means invariably cure. The rule, indeed, is that the morbid tissue disappears only to leave behind it some indelible trace of its presence, and that the patient not only does not get completely well, but is subject to relapses, each more severe than the previous attack. Left to itself, the affection may give rise to serious complications; retention of urine may lead to incurable lesions of the bladder and kidneys, and the position which the patient is obliged to assume may in time give occasion to sloughing bedsores, with possible purulent infection.

Epilepsy, or rather the occurrence of epileptiform attacks, is among the commonest phenomena of syphilitic cerebral disease, a fact which is not surprising when it is remembered that the cortical portion of the brain, the favorite seat of syphilis, is at the same time the seat of the motor centres. The epileptiform attack may occur at the beginning of the cerebral disease, or it may occur during its course as an epiphenomenon of serious import, and one usually presaging fresh complications. At present, only epilepsy as it occurs by itself will be considered.

The utmost importance attaches to the diagnosis between syphilitic and non-syphilitic epilepsy, especially from a therapeutic point of view. The chief characteristics of the variety we have under consideration, are as follows: In the first place, there is nothing peculiarly distinctive with regard to the frequency of the attacks; they may occur daily or they may occur monthly, or they may occur several times in twenty-four hours. Occasionally they recur at certain hours. Night is a favorite time, as it is also for the attacks of common epilepsy. Various causes have been assigned as immediately provocative of the attacks, but these are so numerous and in many cases so trifling that I do not think that they can be seriously considered. With regard to the crisis itself, this is sometimes sudden, the patient dropping as if shot; more frequently, however, there is an aura, often consisting of an inexpressible discomfort at some point, rapidly becoming generalized over the entire body. *The "cry" of common epilepsy is rarely uttered*—an important diagnostic point.

¹ Cases are given by Fournier and Buzzard where paralysis of all four limbs has been entirely cured.

Although the attacks of syphilitic epilepsy are usually precisely similar to those of ordinary epilepsy, yet certain differences in the character of the convulsions, or of the disturbances of ideation, exist at times, and may serve to aid in the diagnosis of doubtful cases. In the first place, the symptoms are less marked both as to generalization, duration, and intensity. The convulsions are only partial. Consciousness in many instances remains intact, or is scarcely affected, and, in a word, the syphilitic epileptic attack is only a feeble representation—a shadow, as it were—of ordinary epilepsy.

In the mildest form, a sudden flash of pain is experienced in one or more limbs, followed by torpor. A more marked phase of the disease is characterized by trembling. A curious group of symptoms, sometimes observed, includes spasm of certain muscles of the trunk and limbs. An individual may be suddenly seized, while walking in the street, with a violent spasm of the posterior muscles of the neck, the sensation being as if the head were being driven down between his shoulders. Now and then one or another of the contractile orifices of the alimentary or air passages is affected, and the patient is suddenly attacked by agonizing dyspnœa, pharyngo-laryngismus, or œsophagismus. Now and then involuntary emission of urine or feces occurs.

The convulsions of syphilitic epilepsy are irregular in appearance and character. One peculiarly characteristic variety is that in which the convulsions are confined to a single limb, generally one of the arms, or to the arm and leg of one side.

Consciousness is not always abolished, and the patient may, as Jullien says, be an anxious spectator of his own epileptic attack. Sometimes there appear to be two stages to the attack, the patient being conscious during the first and unconscious during the last. In some cases torpor lasting even from one to two hours may supervene on the attack. In these cases paralysis is threatened.

Subjective sensations of pain are occasionally observed. They may occur in one part or another of the body or limbs. In one case, severe pain in the testicle complicated the attacks.

Syphilitic epilepsy, unlike ordinary epilepsy, does not remain at a standstill. Left to itself, it may grow better through the relief of the causative lesion, as when a gumma of the cranium softens and opens exteriorly. Much more commonly, the attacks grow more and more frequent, and other nervous symptoms show themselves. This tendency to grow worse, and to result in disorders of intellection of one sort or another, is so characteristic of syphilitic epilepsy as to offer a diagnostic sign of the highest value. The danger of syphilitic epilepsy lies not so much in the epileptic attacks themselves, as in the permanent morbid conditions which so often supervene.

(1) There may be, in the first place, *disturbances of ideation*, the *petit mal* of the French, characterized by vertigo, momentary or brief "absence," ecstacy, and even temporary delirium, in which the patient may impulsively do himself or another some severe injury. The last-mentioned condition is important from a medico-legal point of view.

Independently of these symptoms, *gradual diminution and perversion of the intellectual faculties* may be observed. Benjamin Bell tells of a woman, twenty-six years of age, who was attacked by epilepsy after suffering severe headache. The attacks rapidly acquired extraordinary frequency and intensity (from four to six daily). Suddenly they ceased, and the patient became insane. She had been in this condition for two years when Bell, who had been called in to treat her for ulcers and cranial osteitis, administered mercury, and to his great astonishment saw the mental alienation entirely disappear in the course of a few weeks.

(2) In his statistics, based on the examination of 306 patients suffering with *haut mal*, without distinction as to their character, Echeverria¹ has noted the occurrence of paralysis in 68 instances—about 22 per cent. No doubt this proportion would be increased, if non-syphilitic epilepsies were excluded. Nothing is more frequent, in fact, than to see syphilitic epilepsy complicated by paralysis. At first the attacks leave the limbs weakened and enfeebled for a time. This period of enfeeblement becomes longer and longer, the symptom itself becoming more marked, until gradually complete paralysis steals on. Cases are known, however, in which paralysis has supervened at once after an attack. Paralysis of the motor nerves of the eye and of those of the face is very common in this form of nervous syphilis. Sensorial troubles, especially an involvement of the optic nerve, which can be recognized with the ophthalmoscope, are not uncommon as the result of syphilitic cerebral disease.

Aphasia.—Aphasia is one of those symptoms of syphilitic brain disease which has been studied carefully in the last few years, without, however, much light having been thrown on the obscure points connected with the production of the affection. Pathological investigation in connection with the occurrence of aphasia has shown that this almost always results from a lesion of the left third anterior convolution. The exceptions to the rule are few and obscure. The symptom itself may take on any one of the forms and modifications which are met with in common aphasia.

The prognosis of syphilitic aphasia is very variable. Coming on near the beginning of the brain trouble, and promptly placed under treatment, a nearly complete cure may be looked for; some days of treatment by iodide of potassium work wonderful changes in the symptoms. Relapses of increasing severity are, however, apt to occur. Aphasia unaccompanied by hemiplegia implies a less unfavorable prognosis than in the contrary case. Discontinuity of symptoms is a favorable sign. When these begin to assume regularity and continuity, the patient is growing worse.

Anæmic, Congestive and Apoplectiform Symptoms; Coma.—Cerebral gummata are frequently the centre and origin of more or less localized congestion. They may also give rise to anæmia by compressing an important vessel directly, or by augmenting the intra-cranial pressure generally, and thus closing some of the smaller vessels. Exudation may likewise take place as the result of pressure. It is of course impossible to separate these various conditions, and to decide which in any given case is the cause of the symptoms observed.

The earlier symptoms, which come on gradually, are those observed in ordinary cerebral disturbances of a similar character—transitory affections of the sensory organs, flashes of light, ringing in the ears, and decrease in tactile sensibility. At a later stage intellectual enfeeblement follows.

At a more advanced period, the sensory troubles may be transformed into hallucinations. One of Fournier's patients saw those about him standing on their heads, and the lamp-posts danced around him as he walked the streets. There is difficulty in coördination and loss of muscular sense, so that the patient cannot walk over a polished floor or descend a staircase without unusual precaution and anxiety, the symptoms being, in fact, similar to those of ataxy.

These symptoms too often presage a more severe affection, *apoplexy*, which is very apt to supervene sooner or later.² Maurice Mercier (see Ganul's

¹ On Epilepsy. New York, 1870.

² See the valuable thesis of L. P. Ganul, *Les Tumeurs Gommeuses du Cerveau*, Paris, 1875, containing facts not elsewhere recorded.

Thesis) was the first to draw attention to syphilitic apoplexy, an affection which it is of the highest practical importance to recognize, because it is in many cases curable if taken in time. The following characteristic points may be noted: 1. The affection may occur in young persons. 2. The stroke occurs suddenly, while the patient is in perfect health, without the slightest prodrome such as is commonly observed in severe brain affections. 3. The following symptoms are observed during the attack: complete coma, the eyes closed, the limbs relaxed, not paralyzed, sensibility to marked excitation, persistence of the reflexes, audition unaffected; the patient hears, but cannot reply, or, when pressed, replies feebly by a sign, showing torpor rather than abolition of intelligence; usually vision is interfered with by atrophy of the papillæ, the lesions being unequally developed on the different sides; the irides dilated to the maximum, the upper lids remain closed; there is sometimes strabismus; respiration calm, but stertorous, pulse regular, no fever, paralysis of the sphincters with involuntary defecation and urination, the urine normal, and giving no sign of uræmia. Finally, epileptiform convulsions and vomiting rarely occur.

Special attention should be paid to the presence or absence of these symptoms in all questionable cases. There is no doubt that numbers of patients succumb to what are supposed to be apoplectic seizures, but which are in reality the results of syphilis. A careful examination, with the diagnostic and characteristic features of the disease, as above given, in mind, will in some cases lead to active therapeutic interference with beneficial result.

Intellectual Disturbances.—Owing, as has been said, in speaking of syphilitic epilepsy, to the fact that syphilitic lesions are apt to be situated on the periphery of the brain mass, intellectual disturbances in the later phases of syphilis are among the commoner nervous affections. Sometimes they occur alone, but more frequently in connection with other nervous manifestations, the fact being that the various symptoms rarely occur separately or in regular order, but are more frequently jumbled together.¹ Among the symptoms of a *depressive* character may be mentioned loss of memory. This is rarely complete, and is extremely variable in its nature and in its progress, sometimes being slowly progressive, and at other times occurring suddenly and completely, or in successive attacks. It is apt to be associated with other nervous disorders, such as epilepsy, etc., which may make the diagnosis less difficult. Symptoms of *exaltation* and *perversion*, amounting to true mania, are among the symptoms of cerebral syphilis.

Is there such an affection as *general paralysis*, like the well-known general paralysis of the insane, due to syphilitic cerebral disease? This question has not yet been decided. It is not enough I think to obtain a history of syphilis, or what passes for such; the connection between cause and effect must be drawn closer, and in addition there should be some cases at least in which antisypilitic treatment has proved beneficial in the early stages.

Visceral Disturbances due to Nervous Lesions.—As visceral sensations are commonly located in the occipital lobes, it might be supposed *a priori* that syphilitic lesions in these locations would be followed by visceral symptoms, and such indeed is the case. *Boulimia*, *polydipsia*, *vomiting*, *polyuria*, and even *diabetes* have been shown to be dependent upon syphilitic lesions of the nerve centres.² Diminution of the frequency of *cardiac action*, syncope,

¹ For a more detailed description of the intellectual disturbances of syphilis, see F. Dreer, *La Sifil, e la Pazzia*, Archivio Ital. per le Mal. Nervose, etc., 1869, and Maussurrow, *Die tertiär syph. Gehirnleiden Geisteskrankheiten*. Wien, 1877.

² See the very interesting case of Perroud, *Ann. de Derm. et de Syph.*, t. i., p. 519.

slowing or acceleration of the *respiratory movements*, cough, dyspnoea, etc., have been mentioned as possible results of cerebral nervous disturbance in syphilis, but I do not know of any accurate observations bearing on this subject.

Incoördination of Movement; Ataxy.—A case is recorded by Ganul (op. cit.) where incoördination without muscular weakness occurred in a patient. At the autopsy, an almond-sized gumma was found in the cerebellum. Leven and Neumann have observed vertigo, vomiting, and strabismus in association with incoördination.¹

The question has been discussed of late years, whether syphilis can give rise to locomotor ataxia. The lesion usually associated with the symptoms of locomotor ataxia, is, as is known, diffuse sclerosis of the posterior columns of the spinal cord, a lesion so different from those usually produced by the influence of syphilis upon the nervous system, as to prejudice the mind against the possibility of syphilis causing this group of symptoms. No pathological evidence of the existence of syphilitic locomotor ataxia has been brought forward; but, on the other hand, the indirect clinical evidence in its favor is of the strongest. The question must for the present be considered *sub judice*.²

PROGNOSIS AND TREATMENT OF NERVOUS SYPHILIS.—The gravity of the prognosis of syphilis depends upon the period at which appropriate treatment is instituted, and upon the amount and degree of secondary involvement of the affected tissues. "Against the syphiloma itself," says Jullien, "we are all powerful; against the secondary resultant lesions we are disarmed." Taken all in all, however, the prospects of success are discouraging. Not only is it difficult or impossible in many cases to procure any amelioration, but even when an apparent cure has been effected, successive relapses disappoint both the practitioner and his patient. Add to this that in some cases the cicatrization of the syphiloma itself brings about permanent injury, and the prospect of success seems gloomy. On the other hand, in successful cases the result is often little less than brilliant. (See Van Buren and Keyes, op. cit.) As to the treatment, iodide of potassium is the best remedy. It should be used freely, often in heroic doses: as much as an ounce three times a day has been given by Broadbent. However, in some cases mercury succeeds when the iodide fails, and these remedies should be tried alternately and together when necessary. Of course the ordinary remedies employed in the various neuroses—revulsives, bromides, electricity, hydrotherapy, and hygienic measures—should be used in addition to the more purely specific remedies.³

¹ Leven, Tumeur Syph. du Cervelet. Gaz. des Hôp., 1864.

² See Fournier, De l'Ataxie Locomotrice d'origine Syphilitique. Paris, 1876; A. Reumont, Syphilis and Tabes Dorsalis. Aachen, 1881; also Proceedings of the Int. Med. Congress, London, 1881; and an editorial in the Medical Times and Gazette, Nov. 19, 1881.

³ In addition to the references given in the text, the following monographs and papers on special subjects connected with syphilitic nervous disease may be referred to. Further information of this kind may also be gained from Jullien and Lancereaux.

Hübner, Syphilis of the Brain and Nervous System. Ziemssen's Cyclopædia, Am. ed., vol. xii. Dowse, The Brain and its Diseases; vol. i., Syphilis of the Brain. London, 1879.

Keyes, Syphilis of the Nervous System. N. Y. Med. Jour. Nov. 1870.

Jaksch, Syphilitic Paralysis. Präg. med. Wochen., 1864, Bd. xxii. Nos. 3 und 4.

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Moxon, Syphilitic Disease of the Spinal Cord. Dub. Quart. Jour., vol. li. 1870, p. 449.

De Méric, Syphilitic Disease of the Third Nerve with Mydriasis, without Ptosis. British Med. Jour. vol. i. 1870, p. 29, 52.

H. Mollière, Myélite Syphilitique Aiguë. Ann. de Derm. et de Syph., t. ii. 1871, p. 311.

HEREDITARY SYPHILIS.

ETIOLOGY.—Regarding the manner in which syphilis is transmitted from parent to offspring, there is as yet no agreement among syphilologists. Whether a syphilitic father can impress his disease upon the fecundating germ, so that the resulting foetus shall be syphilitic without the intervention of the impregnated female, or whether syphilis can only pass to the foetus through the mother, are questions upon which the best authorities differ widely. Numerous cases tending to prove one view or the other, and going to show on the one hand that syphilis can come only from the mother, or, on the other hand, that it may proceed from the father alone, have been reported, but the majority of these reports are lacking in convincingly precise details, and many are ludicrously wanting in care and accuracy. To some so-called “observers” no case can be so destitute of well-ascertained data as to be unserviceable in proving the preconceived theory.

A careful examination of the cases thus far reported by trustworthy observers, and a comparison of these with my own personal experience, incline me to the belief that, while in the majority of cases of hereditary syphilis the mother has been syphilitic, yet that a certain number of carefully observed cases, reported by some among our ablest living clinicians, go to indicate that a syphilitic father may procreate syphilitic children, the mother remaining to all appearance, and in all likelihood, perfectly healthy.

The chief champion of the paternal influence in this county is Dr. R. W. Taylor, but although most of our syphilographers, as far as they have expressed themselves in print, are inclined to take this view of the subject, there are not wanting others, prominent among whom is Dr. F. R. Sturgis, who stoutly deny the possibility of syphilis being transmitted to the ovum in utero by the semen of the male parent, without the mother being infected either by the husband or by the ovum.

- D. Mollière, *Cas d'Anosmie Syph.* Ann. de Derm. et de Syph., t. iii. 1871, p. 74.
 Lunggren, *Syphilis of Brain and Nerves.* Archiv für Derm. u. Syph., 1872.
 Owen Rees, *Cerebral Syphilis.* Guy's Hosp. Reports, 1872, p. 249.
 Gross, T. M. B., *Clinical Observations upon Syphilitic Diseases of the Nervous System.* Am. Jour. Syph. and Derm., vol. iii. 1872, p. 216.
 Petroff, *Ueber die Veränderungen des sympathischen Nervensystems bei const. Syph.* Virchow's Archiv, lvii.; Cbl. f. Med. 1873, p. 510.
 Charcot and Gombault, *Syphilis des Centres Nerveux.* Arch. de Physiol., 1873.
 Hughlings Jackson, *Syphilis of the Nervous Centres.* Med. Times and Gaz., 1873.
 Delafield, *Syphilitic Tumors of the Spinal Nerves.* Am. Jour. Syphilog. and Dermatol., vol. iv. 1873, p. 26.
 Buzzard, *Clinical Aspects of Syphilitic Nervous Affections.* London, 1874.
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 Balfour, *Neuralgia as a symptom of Syphilitic Cerebral Disease.* Edin. Med. Jour., Oct. 1875.
 Mauriac, *Mémoire sur les Affect. Syph. précoces des Centres Nerveux.* Ann. de Derm. et de Syph., t. vi. 1875, p. 161.
 Mauriac, *Leçons sur l'Aphasie, et De l'Hémiplégie Droite Syph. à forme interne.* Gaz. Hebdom., 1876.
 Servantie, *Des Rapports du Diabète et de la Syph.* Thèse de Paris, 1876.
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 G. Homolle, *Méningo-myélite Subaiguë à la fin de la période séc. de la Syph.* Mém. et Bull. de la Soc. Anat., p. 514, 1876.
 Fournier, *De l'Atax. Loc. et de l'Épilepsie Syph.* Ann. de Derm. et de Syph., t. vii. 1876, pp. 187, 228.
 Fournier, *Paral. du Mentonnier, par lésion syph. du Maxillaire Supérieur.* Gaz. des Hôp. No. 34, 1877, p. 271.
 R. H. Alison, *Some Cases of Syphilitic Chorea.* Am. Jour. Med. Sci., vol. lxxiv. 1877, p. 75.
 Fournier, *Syphilis du Cerveau.* Paris, 1879.
 Reumont, *Syphilis and Tabes Dorsalis.* Aachen, 1881.
 R. W. Taylor, *Clinical Notes on Neuralgia of the Sciatic Nerve, caused by Syphilis.* New York Med. Jour., March, 1880.
 Reuben A. Vance, *Syphilitic Epilepsy.* Am. Jour. Syph. and Derm., vol. ii. 1871, p. 208.

The two following cases, which I select as illustrating the difficulties of the subject, show the strongly convincing facts which may be brought forward for either view:—

Mireur¹ gives the following striking illustration of syphilis in the father failing transmission in procreation, only to be conveyed to his child by direct contact after birth. M. C. suffered with chancre and generalized symptoms, for which he was treated, and was apparently cured. About ten or eleven months after the chancre he married. His wife at once became pregnant, and gave birth to a healthy child who remained well up to the age of two years. Meantime M. C. had now and then some "vague souvenirs" of his former disease, and at the end of this period showed a slight erosion on his lower lip. As he thought nothing of this indolent lesion, he continued to fondle and kiss his child as usual. A short time after, however, the child showed a well-marked labial chancre, followed by generalized symptoms.

Taylor,² on the other hand, gives this equally convincing illustration of the exclusive paternal transmission of syphilis: A woman to all appearance healthy, under the careful scrutiny and observation of Dr. Taylor himself, but whose husband was and continued to be the subject of syphilitic disease, gave birth to four syphilitic children in succession. Then, her husband coming under treatment, she gave birth to a healthy child. Afterwards, the husband having neglected treatment meanwhile, and having suffered a relapse of his syphilitic disease, the wife gave birth to a syphilitic child. Finally, a year or two subsequently, the husband having once more submitted to a thorough course of treatment, the wife gave birth to a healthy child. The wife remained without treatment, excepting the use of quinine and iron, through the whole period of this history, and at no time showed any signs of syphilitic disease.

A few cases have been reported going to show that even when both parents present the evidences of syphilitic disease, the infant may be free from syphilis; but these observations must be regarded as doubtful, excepting where the parents have both been under treatment at the time of conception, and the mother subsequently, or where the disease is of long standing, only manifesting itself in sluggish local affections.

A certain immunity to the child exists in late syphilis of the mother. I have at present under observation a woman in her twelfth year of syphilis, who conceived while suffering from a gummatous ulcer of the arm, for which irregular and insufficient treatment was pursued, with intervals of no treatment, a month or more in duration. This woman gave birth to a child which now, sixteen months old, has *as yet* shown no sign of syphilitic disease, but is fat and flourishing. The mother's lesion is gradually healing under more regular treatment pursued of late.

As regards the influence of father and mother after conception, that of the former may be dismissed as *nil*. The so-called cases of infection of the fœtus by syphilitic semen are now known to be incorrectly reported, since repeated experiments have shown that semen cannot convey the syphilitic virus.

It is otherwise with the mother. If she has conceived a healthy child by a healthy father, and is subsequently contaminated, the fœtus will suffer. How long and to what period this susceptibility of the fœtus to the syphilis of the mother exists, cannot be accurately stated. Most observers agree in admitting that if the mother is infected with syphilis before the seventh month of pregnancy, the fœtus can hardly escape. After that date, it is uncertain whether or no the maternal influence can be reckoned as giving rise to syphilis in the infant. Most of the cases of later infection lack the essential data to be convincing.

The idea formerly entertained that the child could contract syphilis during birth from chancre, mucous patches, etc., upon the external genitals of the mother, has been dispelled by the result of practical observation, which shows

¹ Essai sur l'Hérédité de la Syphilis. Paris, 1867.

² A Contribution to the Study of the Transmission of Syphilis. Archives of Clinical Surgery, Sept. 1876

simply that such is not the case. No instance has ever, to my knowledge, been reported where an infant has displayed a chancre derived from contagion during the process of birth.

In connection with the etiology of hereditary syphilis, "Colles's law" may be mentioned. It is well known that a diseased child almost invariably infects a healthy wet-nurse who suckles it, but the infection of a mother by suckling her own diseased child is as yet unknown. This fact was first noticed by Abraham Colles, of Dublin, in 1837. It has been called by Mr. Jonathan Hutchinson "Colles's Law."

The doctrine of *choc en retour*, or the transmission of syphilis from the fœtus to the mother, was taught by Ricord, and has been more recently maintained by Hutchinson and Dickinson, who assert that a man may beget an infected child which may convey the syphilitic virus to the mother. The chief ground for the acceptance of this view is found in the fact that mothers having produced syphilitic children, themselves develop specific symptoms during or soon after pregnancy. I think that, although there is nothing improbable about this theory, no conclusive evidence has as yet been brought forward to sustain it.

PATHOLOGY. *Syphilis of the Placenta.*—The syphilitic lesions of the placenta are as yet only imperfectly understood. According as it is circumscribed or not, syphiloma gives rise to gummatous placental endometritis, or to diffuse interstitial placentitis. Commonly both forms are associated. In the circumscribed form, the lesions often present the appearance of papular or condylomatous neoplasms, implanted in the free portion of the decidua, and formed of a very vascular mucous tissue. Sometimes they resemble hard tumors, and penetrate the tissue of the placental cotyledons like wedges. The fatty degeneration which results in these gummatous deposits makes it easy to confound them with tuberculous masses. The absence of vessels, the presence of refractive granulations, like those observed in syphilis of the liver, together with the sclerosis and concomitant external symptoms, will settle the diagnosis.

SYMPTOMATOLOGY OF HEREDITARY SYPHILIS.

DATE OF APPEARANCE OF THE LESIONS.—The only certain way of ascertaining the appearance of the earliest symptoms of hereditary syphilis is to watch for skin eruptions. Earlier visceral lesions there may be, but of these we can take no certain cognizance during life.

The statistics of Diday and Roger, comprising 172 cases, show the following various dates after birth of the appearance of hereditary syphilitic symptoms:—

Before the end of the first month in	.	.	.	.	.	92 cases.
“ “ third “	.	.	.	.	.	67 “
“ “ fourth “	.	.	.	.	.	7 “
“ “ fifth “	.	.	.	.	.	1 case.
“ “ sixth “	.	.	.	.	.	1 “
After the sixth month . . . . .	.	.	.	.	.	4 cases.

It is thus seen that in the great majority of cases hereditary syphilis shows itself before the end of the third month. A few cases have been reported where the appearance of the symptoms has not occurred until the fifteenth month, and Diday gives one case where the visible outbreak was delayed until the end of the second year; but these cases are very exceptional.

Of late years our knowledge of the subject of hereditary syphilis has been much enlarged, and various affections occurring in late infancy and in childhood, formerly unclassified, are now included under this head. In some reported cases, it appears that these late lesions have not been preceded by any earlier symptoms, but the difficulty in obtaining facts in regard to such points can easily be understood. It is certain, however, that in many of these cases good results have been obtained by antisypilitic treatment.

The mortality of syphilitic children is very great, fully one-third failing to reach maturity. Abortion resulting from the death of the fœtus usually occurs about the sixth month, while that caused by infection of the mother during pregnancy takes place somewhat later. An aborted fœtus is usually in a macerated condition, the skin being easily detached, and the surface having a livid, purple color, while various lesions will be found in some of the viscera.* The integument may show nothing characteristic, or large bullæ may be found on the soles and palms.¹ (Bumstead and Taylor.)

Syphilitic children generally present a healthy appearance at birth, and for a week or two all seems to go well. Then symptoms of debility and decreased vitality show themselves, the infant begins to emaciate, and grows wizened and aged in appearance. Catarrh of the nasal passages—"the snuffles"—shows itself, interfering with respiration, and thus sometimes itself alone being the cause of death. The skin becomes yellow, loose, and wrinkled. It is drawn tight over the bones of the face, which becomes sallow and earthy, with prominent eyes and a peculiar senile expression, the infant presenting the appearance of decrepit old age. Usually the symptoms of failure of nutrition, and of disease, occur at an earlier date if the affection is severe. Now and then, however, excessive emaciation is not observed even when the syphilitic poison has affected the system to a marked degree, just as we see adults who go through a course of syphilis in its various manifestations without appearing to suffer thereby in general health.

SKIN MANIFESTATIONS IN HEREDITARY SYPHILIS.—The syphilitic eruptions of infants are in all respects the same as those of adults, excepting in so far as their appearance is altered by the peculiarities of structure of the infantile integument.

The erythematous syphiloderm is that which is earliest and most frequently observed. It generally makes its appearance about the third week of life, often accompanied by coryza, and showing itself first on the abdomen in the form of minute, round or oval, pink macules. It spreads rapidly over the surface of the body and limbs, and the patches grow larger and darker, until they may be half an inch in diameter, slightly or not at all elevated above the surface, coppery red in color, and no longer, as at first, disappearing under pressure. There is usually little or no scaliness, excepting upon the hands and feet, where slight desquamation may be present, especially if the eruption is well marked.

This eruption is very liable to be confounded with the simple erythematous rashes of early infancy. The most important diagnostic points are the tendency to infiltration, and the formation of papules in places where the skin comes together in folds, as about the neck, and also especially in the region of the genitalia and nates.² In addition, the tendency to scaliness about the palms, soles, and occasionally the nates, is more or less characteristic. Occasionally this eruption is extremely difficult to distinguish from erythe-

¹ See Plate XXIII, Fig. 2.

² Plate XXIII, Fig. 1 gives a fair representation of this form of eruption running into the papular variety.

matous eczema; and I have in several instances met with cases where a diagnosis was at first impossible, and was only arrived at after holding the patient for some time under observation, the simplest local remedies being used, and the development of the case being carefully watched. Of course the syphilitic eruption, were it such, would be apt to go on from bad to worse, and to be accompanied by other symptoms, while the eczematous eruption would either get well under the simple local treatment, or would develop some characteristic signs, such as weeping, papulation, vesication, etc.

The *papular syphiloderma* is not unfrequently met with in connection with the erythematous form of the disease. It is sometimes the first eruption to be observed. The lesions are large and small, flat papules, with a dull-red, afterwards a coppery, color, and a smooth surface. Occasionally they may exfoliate to some extent, especially upon the palms. Sometimes a number of papules fuse together, and form a patch of a dull-red color, much thickened and occasionally scaly. Such patches may occur, covering the entire foot or hand, or a portion of the thigh (as in Plate XXIII. Fig. 1).

When they are seated about the anus or genitalia, the heat and moisture of the parts, with the frequent maceration in urine and fecal discharges to which infants are subject, conduce to the formation of mucous papules. These skin lesions, which are among the commonest of hereditary infantile syphilis, are quite characteristic. At times they tend to condylomatous outgrowth, and may resemble the simple acuminate condylomata of infants from which they are to be carefully differentiated.

The chief distinctive feature of syphilitic condylomata in infants is that the acuminate excrescence springs from a previously existing papule, similar ones usually being visible in the immediate neighborhood. There is also usually a certain amount of extremely fetid discharge of a characteristic odor, in syphilitic condyloma acuminatum, while in the simple condyloma this is not so marked a feature. When the papules are situated about the mouth or at the commissure of the lips, they are usually moist, and in this position are the most frequent carriers of contagion to the nurse, in nursing, and to other children, or adults, in kissing. It is hardly necessary to say that the moist papule in the infant, as in the adult, is one of the most frequent mediums by which syphilis is propagated. The abominable habit, prevalent in this country and perhaps in others, of submitting infants to the caresses of every chance comer, is responsible for many cases of mysteriously contracted disease; and it seems to me a part of the duty of the family physician to warn mothers of the dangers thus incurred.

When the papule occurs in the commissure of the lips, it leaves in healing slight linear or radiating scars, which may subsequently aid in the diagnosis of previously existent syphilis.¹

The *vesicular syphiloderma* is a very rare affection, sometimes resembling vesicular eczema to a certain degree. It generally occurs in connection with other lesions, pustular, bullar, etc. The vesicles are usually distinct, seated upon firm infiltrated or papular bases, and show no inclination to coalesce, though they sometimes tend to involve the deeper layers of the skin.

The *pustular syphiloderma* may occur before the eighth week, in children profoundly affected with syphilis, but usually shows itself at a later period. According to the severity or mildness of the disease, the pustules are large, numerous, and deep; or small, few, and superficial. The lesions are commonly most abundantly met with on the thighs, buttocks, and face, although

¹ I regard this as a more certain testimony of previously existing syphilitic disease than the so-called "Hutchinson's teeth," to be presently described, because it is not likely to be confounded with any other cicatrix. I do not know of any affection capable of leaving such traces.



2.



1.

Infantile syphilis.

they may occur in any part of the body. About the face they often tend to group, and to form crusted patches resembling at first sight the lesions of contagious impetigo, or of impetiginous eczema. From the latter, however, they are to be distinguished by not itching, by the thickness and greenish-brown color of the crusts, those of impetiginous eczema and impetigo being thinner and lighter yellowish-brown, like honey. The eroded surface underneath the crusts tends in eczema to heal over, and always without a scar, whereas the syphilitic erosion is more inclined to be ulcerative. The base of the lesions in syphilis is thickened, and they are surrounded by a violaceous red areola. Syphilitic acneiform lesions are sometimes met with on the scalp, in infants, while ecthymatiform pustules are encountered about the limbs in severe cases. These last are apt to result in loss of tissue.

The Furunculoid Syphiloderm.—Bunstead and Taylor describe a furuncle-like eruption which may occur as early as the sixth month, or as late as the third year of hereditary syphilis. The lesions may occur alone, constituting the only symptom of the disease, or they may be accompanied by other eruptions. Their number varies greatly in different cases. They begin as small nodules in the corium, and gradually increase to the size of half a nutmeg, ulcers form on the summit, sloughs are thrown off, and irregular, unhealthy cavities with scanty effusive secretion are left, the lesions subsequently running a chronic course. They often result in cicatrices.

The tubercular syphiloderm is a rather rare manifestation of hereditary syphilis. It may occur as early as the sixth month, or as a recurrent affection at two or three years. The tubercles begin as deeply seated papules or nodules; the skin is involved afterwards, and finally ulcers of greater or less size result, with abundant secretion, and often covered with crusts. Occasionally vegetations may spring up from the surface of the ulcer as in the following case reported by me several years ago.¹

An infant of eight months with a well made out syphilitic history showed progressive emaciation, snuffles, and an eruption, situated chiefly upon the face, though observable elsewhere. The lesions when recent consisted of discrete, indolent, tubercular elevations, of pin-head to pea size, roundish, well-defined, firm, and elevated. Older lesions were seen to have coalesced into elevated coin-sized patches, with here and there pustular points, coalescing in places into ulcerated patches covered with brownish laminated crusts. One of these, larger than the others and situated on the cheek, showed a rough, uneven, warty, mammillated surface, covered with a crust. On poulticing this, a shining red surface, covered with vegetations, could be observed. The abundant secretion was horribly fetid. The eruption closely resembled a patch of impetiginous eczema, but the infiltration of the skin, the mammillated surface, the abundance and fetid character of the discharge, and the thick, opaque, brownish crusts, served to make the diagnosis plain even without considering the characteristic lesions elsewhere.

The tubercular syphiloderm is to be differentiated from the scrofulodermata of the skin sometimes found in infants and young children. The lesions resemble one another closely, and a careful investigation of the history of the case, with a close examination of the lesions in the light of the description given under the head of syphilodermata in adults, will be required to make the diagnosis. *Gummata* of the skin are not very unusual among children affected with hereditary syphilis. They are usually among the later lesions to show themselves, and sometimes a single lesion alone exists to mark the presence of the disease. They resemble in all respects the gummata found in adults.

Bullar Eruptions.—The bullar eruptions of new-born children ("pemphigus

¹ A case of Vegetating Tubercular Syphiloderm in an Infant. Archives of Dermatology, vol. iii. 1877, p. 211.

neonatorum") have given rise to much discussion, and it was at one time considered that all such eruptions were of a syphilitic character. A true pemphigus neonatorum is now admitted, although this is a very rare disease.¹ It commonly occurs at a later date than the syphilitic bullar eruptions. The latter are most usually found upon the palms and soles (see Plate XXIII. Fig. 2). The skin shows patches of a violet color; in a short time small confluent vesicles make their appearance upon these spots, and then coalesce and grow larger until the fully formed bullæ show themselves, varying in size from that of a pea to that of a hen's egg, with a yellowish-green, opalescent color, and purulent contents. Occasionally the lesions are brownish or even hemorrhagic. The areolæ are large, dark, and violaceous. Within twenty-four or thirty-six hours the bullæ break or dry up, leaving whitish crusts covering shallow ulcers. The eruption is of grave import, and rapid cachexia with general enfeeblement leads rapidly to a fatal termination. The bullar syphiloderm is to be differentiated from the pemphigoid eruption by its earlier appearance, by its usually more serious character, and by the concomitant symptoms and history. Sometimes impetigo contagiosa of young infants is mistaken for the bullar syphiloderm, but this eruption is of trifling import, its early appearance is different, and the crust when removed shows only a slight erosion. Moreover, the places of election of impetigo contagiosa are the face and mouth, the backs of the fingers and hands, and less frequently the wrists; the feet usually escape.

AFFECTIONS OF THE MUCOUS MEMBRANES.—One of the earliest symptoms of hereditary syphilis commonly observed is coryza or "snuffles," due to structural changes in the mucous membrane of the nasal passages, at first of an erythematous, and later of an ulcerative character. This may be slight, or it may be so severe as to interfere with respiration, particularly during sleep and nursing. At first serous, the discharge soon becomes purulent, and sometimes bloody and very offensive, excoriates the angles of the nasal opening, becomes inspissated, and plugs up the nasal passages. Sometimes the disease penetrates to the bony structures, and produces necrosis.

Mucous patches of the mouth in infantile hereditary syphilis do not present the typical opaline appearance seen in the adult. The lesions tend to coalesce and ulcerate, and, when occurring at the angles of the mouth in connection with moist papules of the outer surface, deep fissures sometimes supervene.

The serous secretion of mucous patches is highly contagious, and their early recognition is a matter of the utmost moment in order to prevent the risk of contamination. The infant must not be permitted to nurse at any breast but that of its mother, and must be placed in a rigid quarantine; all kissing and fondling, the use of utensils employed by others, etc., must be guarded against. The infection of the nurse by a child having mucous patches of the mouth is particularly liable to occur in hospitals, lying-in asylums, and the like.²

The mucous patches of hereditary syphilis are to be distinguished from the lesions of simple stomatitis, by the fact that in the latter the inflammation is generally more diffuse, the whole tongue in particular being intensely affected, and often covered with vesicles, which are not seen in the syphilitic affection. The tendency to the development of mucous patches at the corner

¹ A very good description of the various non-syphilitic bullar eruptions of the skin in infants, generally classed as pemphigus, will be found in an article by Gustav Behrend, of Berlin. *Beitrag zur Lehre von Pemphigus*. Vierteljahrsschr. f. Derm. u. Syph. Jahrg. vi. 1869, S. 191.

² See an important paper by Dr. R. W. Taylor, *The Dangers of the Transmission of Syphilis between Nursing Children and Nurses in Infant Asylums and in Private Practice*. (Am. Jour. Obstet., Nov 1878.) Also Fournier, *Nourrices et Nourrissons Syphilitiques*. Paris, 1878.

of the mouth is also a valuable diagnostic sign. In stomatitis, the gums and the sulci between these and the cheeks are often the seat of the lesions, while those of syphilis are not found in that locality. Of course the history of the case and the concomitant symptoms must be taken into consideration.

Gummata of the mucous membranes are occasionally met with, but not in the earlier periods of hereditary syphilis. The features which these present in the infant are not different from those described as occurring in acquired syphilis of the adult. They are liable to be mistaken for strumous ulceration, but the history and general character of the lesion—being irregular, less sharply defined, and spreading more rapidly—will aid in the diagnosis.

AFFECTIONS OF THE VISCERA IN HEREDITARY SYPHILIS.—As in the acquired syphilis of the adult, so also in hereditary syphilis, the disease spares no organ or viscus. Our space, however, does not permit the discussion of the various affections in detail, and the lesions of the bones and the nervous system alone will therefore be described.

AFFECTIONS OF THE BONES.¹—These are described by Bumstead and Taylor under the heads of *osteo-chondritis*, *periostitis*, and *dactylitis syphilitica*. The former is the most common osseous affection, and frequently its presence decides the syphilitic nature of coexisting lesions. The bones most commonly attacked are those of the forearm, the leg, the arm, and the thigh. The clavicle, sternum, and ribs are also attacked, as well as the metatarsal and metacarpal bones. In these cases of *osteo-chondritis*, a swelling, often imperceptible in fat children, is observed at the diaphyso-epiphyseal junction. There is a ring or collar around the bone at this point, or in some cases a less distinctly defined swelling. When two contiguous bones are affected, they often seem to be fused together.

The swellings may be developed slowly or rapidly; they are commonly indolent, and do not interfere with the movements of the joints, although these may become secondarily involved. The lesion may break down, soften, and ulcerate, the ends of the fragments of bone protruding through the opening. Separation of the epiphysis from the diaphysis is not uncommon. When resolution occurs, if the diseased action has progressed to any considerable extent, the cartilage having been destroyed, shortening of the bone takes place. Sometimes, however, the bone appears to be restored in its integrity. A curious condition of pseudo-paralysis of the involved limb often occurs in connection with this affection.²

Periostitis is a later affection, attacking the bones of children who have already begun to walk. The femur and tibia are first attacked, the greater part of the shaft being often involved, with general thickening and bowing anteriorly, producing marked deformity. The fibula is sometimes attacked, and both legs are apt to be affected. Occurring later in life the affection is more apt to be unilateral. Sometimes the bones of the skull are attacked, and the nodes occasionally break down and form troublesome abscesses. *Periostitis* usually occurs before the twelfth year, but may, in exceptional cases, be seen at a later period.³

¹ Our knowledge of these lesions is comparatively recent, and derived from the labors of Wegner, Ueber hered. Knochensyphilis bei jungen Kindern (Arch. f. path. Anat. Bd. l. 1870); Waldeyer und Kobner, Beitr. z. Kenntniss der hered. Knochensyphilis (Arch. f. path. Anat. Bd. lv., 1872); Parrot (Arch. de Physiol. Norm. et Path. 4me Ann., 1872); and R. W. Taylor, Syphilitic Lesions of the Osseous System in Infants and Young Children. New York, 1875.

² I recently reported an interesting case of this affection, in which the pseudo-paralysis was a marked symptom. A case of Bone Syphilis in an Infant accompanied by Pseudo-paralysis, etc. (Phila. Medical Times, Oct. 11, 1879.)

³ Two marked cases of hereditary syphilitic disease are shown in Figs. 335 and 337.

Dactylitis syphilitica is usually observed in very young children, but may occur as late as the twentieth year. It is characterized by swelling of the phalanges, followed in some cases by absorption. The metacarpal and metatarsal bones are likewise the seat of similar affections. The swellings in the latter case usually form rapidly, and attain considerable size; the integument may ulcerate. The treatment of all bone swellings should combine the administration of both mercury and iodide of potassium.

The following ointment may be used externally:—

R.—Ung. hydrarg.,
Ung. zinci ox. āā ʒss.
Bals. Peruv. ʒj: M.

Graduated pressure is often advantageous.

In connection with diseases of the osseous system in infants, reference may be made to the recent discussions on the relationship between rickets and hereditary infantile syphilis. The writings of Parrot, and the debate on the subject in the London Pathological Society, a year or so ago, may be referred to in this connection. As the subject is as yet confused and obscure, notwithstanding the recent attempts to shed light upon it, I do not think it profitable to enter into its discussion here.

CORNEA AND TEETH.—The affections of the cornea and of the teeth in hereditary syphilis demand a passing notice, on account of the diagnostic importance which has been attributed to them. Some years ago, Mr. Jonathan Hutchinson¹ brought forward the view that the peculiar inflammation of the cornea usually occurring between the ages of three and twenty, and known by the name of strumous keratitis, was always due to hereditary syphilis. This, which is a diffuse keratitis, gives rise to a hazy appearance of the cornea, causing it to look like ground glass. In connection with this condition of the cornea, certain changes in the teeth take place. The exact nature of these, and the appearances presented, having been frequently misunderstood, Mr. Hutchinson² gives the following memoranda for the avoidance of error in diagnosis.

- 1 No special peculiarities are to be looked for in the first set of teeth.
- 2 There can be no more serious blunder than to imagine that bad teeth in proportion to their badness of form are to be suspected of syphilis.
- 3 The upper central incisors are the only teeth which are positively characteristic. The others may afford corroborative testimony, but are not to be relied upon alone.
- 4 The chief peculiarity is a general dwarfing of the tooth, which is both too short and too narrow, and, from its sides slanting together, presents a tendency to become pointed. This tendency to pointing is always defeated by the cutting off of the end, the truncation being usually effected in a line curved upwards so as to produce a single shallow notch. At the bottom of this notch the enamel is deficient and the dentine exposed, but there is no irregular pitting, as in stomatitis teeth.
- 5 The malformations are unusually symmetrical, and affect pairs of teeth. The two central incisors resemble each other, and the two laterals are also alike. If any defect passes horizontally across all the incisors at the same level, and affects them all alike, it is probably not due to syphilis.
- 6 In syphilis the lateral incisors usually show little or no malformation.
- 7 The occurrence of the peculiarities due to syphilis and those due to mercury in the same mouth are exceedingly common.³

The importance to be attached to the characteristic appearance of the teeth in hereditary syphilis has been disputed by some observers. For myself,

¹ Ophthalmic Hosp. Rep., vol. i. p. 229.

² Illustrations of Clinical Surgery, fasc. xi. London, 1878.

³ I do not think that this remark will apply to America.

although I have carefully examined a considerable number of subjects of inherited syphilis, during the past few years, yet I cannot say more in favor of the diagnostic value of these teeth than that, when present in typical form, they have a certain weight in favor of the existence of hereditary syphilis in the given subject. I should hesitate to base a diagnosis in a doubtful case upon the evidence of the teeth alone. The annexed illustrations, some of which are taken from Hutchinson, and one from W. F. Norris, show several varieties of syphilitic teeth.

Fig. 339.



Fig. 340.



Fig. 341.

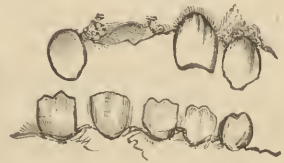


Fig. 342.

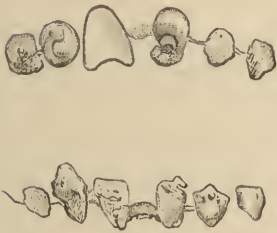


Fig. 343.



Fig. 344.



Syphilitic teeth.

AFFECTIONS OF THE NERVOUS SYSTEM.—The affections of the nervous system in hereditary syphilis have been studied chiefly by English physicians, and during the past decade.¹ Many cases of brain disease formerly believed to be of tubercular origin are now known or suspected to be syphilitic in character. The results of meningeal inflammation, such as thickening and adhesion of the membranes by the development of fibrous tissue and gummy material, and the endoarteritis often observed in syphilis of adults, have been noted in infantile syphilis. Gummata have also been observed, and the prevailing impression among investigators at present tends to the belief that the same nervous affections may occur in hereditary as in acquired syphilis.

Our present knowledge of these affections is, however, very incomplete. Jackson has described the chorea of hereditarily syphilitic infants and young children, which is sometimes a slight affection, while at other times it is more severe and may lead to epilepsy. Other writers have described cases of facial paralysis. The nervous affections of hereditary syphilis, like those of the acquired disease, are disorderly and complex in the development of their symptoms; a quite characteristic point.

¹ See Hughlings Jackson, *Cases of Diseases of the Nervous System in Patients the subjects of Hereditary Syphilis*. London, 1868; and *Nervous Symptoms in Cases of Hereditary Syphilis* (*Journ. Mental Sciences*, Jan. 1875); also Barlow (*Trans. Path. Soc. Lond.*, vol. xxviii. 1877); and T. Stretch Dowse, *The Brain and its Diseases*. London, 1877.

What is known of these nervous affections should lead to the careful examination of every case of chorea, epilepsy, etc., occurring in children, with the view of ascertaining, if possible, the presence or absence of a syphilitic taint. In this connection, the rules for examining cases of suspected hereditary syphilis given by Mr. Hutchinson,¹ are of value.

He says that although the teeth taken alone are the most valuable signs in adolescents by which inherited syphilis is recognized, yet there are others of importance which will aid the diagnosis or supply the lack of information from the teeth. These are:—

(1) A group of physiognomical peculiarities: (a) sunken bridge of nose; (b) prominent frontal eminences; (c) scars at corners of mouth; (d) silky softness of skin with absence of color.

(2) History of past attack (or evidence of present one) of interstitial keratitis. This disease usually affects both eyes and causes very great defect of sight, lasting over several months; then it clears away, leaving the corneæ a little cloudy, or it may be perfectly bright. Afterwards there remains a peculiar steel-gray lustre on the iris.

(3) The presence in the choroid of scattered patches of absorption, especially in the peripheral regions. These will often afford conclusive evidence when other symptoms fail.

(4) The presence of periosteal nodes on one or on many of the long bones.

(5) The occurrence present or past of a peculiar form of phagedenic ulceration, sometimes erroneously called lupus. This may affect any part, but is often seen in the face or in the throat.

TREATMENT.—The treatment of hereditary syphilis must begin, when possible, with the fetus in utero. The surest means of preserving the product of conception and bringing it to maturity, is in beginning the treatment of the mother at the earliest possible moment, and continuing it vigorously until after the birth of the child.

Mercurials are best given by inunction during pregnancy, as we by this means spare the stomach, and avoid the danger of intestinal irritation which may go so far as to cause the abortion which it is our object to prevent. There are some cases, however, in which inunction cannot conveniently be employed, and here mercurials by the mouth, if given with due precaution, are often well borne, and may at least be tried.

The infant, when born, should be placed under the best possible hygienic circumstances, and should be nourished at the mother's breast. No harm can come of this to either. Bottle-feeding is a very inadequate means of nourishment at best, and in the syphilitic infant may determine such failure in health as to cause the disease to take much firmer hold upon the system than it would do otherwise. It seems hardly necessary to say that the syphilitic infant should not be given to a wet-nurse, unless that nurse be herself syphilitic. This is sometimes done by mistake, in the case of infants not known to be syphilitic, with the gravest consequences—the disease being thus imported into a healthy family, and infecting, perhaps, several members.²

For the medical treatment of syphilis in very young infants, baths and inunctions are preferable. The best form of mercurial bath is made by simply dissolving ten grains of powdered corrosive sublimate in about a bucketful of water, employing a small tub just large enough for the child to sit in comfortably. The water, of course, should be warm, and the bath should be given with due precaution against cold. A flannel skirt tied around the infant's neck and spread over the tub, will prevent any of the

¹ Illustrations of Clinical Surgery, fasc. xi.

² See Fournier, *Nourrices et Nourrissons Syphilitiques*, Paris, 1878; and R. W. Taylor, *The Dangers of the Transmission of Syphilis between Nursing Children and Nurses in Infant Asylums and in Private Practice* (Am. Journ. Obstet., vol. viii., Nov. 1875).

water from being splashed into the nose or eyes. The infant should be allowed to remain in the water at least ten or fifteen minutes, and should be then dried and powdered with starch—or, if there are any moist papules, these may be dusted with a powder of equal parts of calomel and oxide of zinc—and should then be put to bed. One bath should be given daily.

Many authorities object to the use of baths in hereditary syphilis, but I have had such good results from their use that I prefer them to all other forms of medication, where they can be used with safety and convenience.

The best method of employing mercury by inunction is in the form of a dilute mercurial ointment, such as the following:—

R.—Ung. hydrarg. ℥j.
Unguenti, ℥j. M.

This is to be smeared over a flannel roller, which is bound about the infant's body and changed once in twenty-four hours. Sir Benjamin Brodie, who strongly recommended this plan of treatment, said that he had never found it to fail.

The internal administration of mercury or of iodide of potassium to very young children, is neither necessary nor desirable; in fact, I think it objectionable, as I have often seen the stomach upset by the administration of these drugs. In the case of older children, however, it may sometimes be desirable to administer the medicines in this manner. One of the best forms of giving mercury to children is in "gray powder," as follows:—

R.—Hydrargyri cum cret. gr. ij ad vj.
Pulv. sacch. alb. gr. xij. M.

To be divided into twelve powders; one three times a day.

The following formula (a modification of the well-known *Sirope Gibert*) is convenient when it is desirable to employ the "mixed treatment":—

R.—Potassii iodidi, gr. v.
Hydrargyri biniodidi, gr. $\frac{1}{10}$.
Syrupi, f℥ij.
Aquæ, ad f℥ij. M.

Teaspoonful three times a day for a child of a year old, with an increase proportional to that of the age.

The treatment should be continued for a considerable time—at least three or four months—after all symptoms have disappeared.

The attempt has often been made to give mercury and iodide of potassium to infants through the medium of the mother's milk, but the effects have not been so decidedly favorable as to suggest this as an appropriate method. I am inclined to doubt if mercury can be given in this manner, but I believe that experiment has shown that iodide of potassium is found in the milk of nursing women to whom it is being administered by the mouth.¹

¹ The following papers may be referred to as giving additional information on subjects connected with hereditary syphilis:—

Atkinson, An Account of a Case of Syphilis inherited through Two Generations (Archives of Dermatology, Jan. 1877);

Bulkley, Rare Cases of Congenital Syphilis (New York Med. Jour., May, 1874);

Id., Two Cases of very late Hereditary Syphilis (Archives of Dermatology, April, 1878);

Hyde, On the Immunity of certain Mothers of Hereditarily Syphilitic Children (Transactions of the American Dermatological Association, Archives of Dermatology, April, 1878);

Atkinson, Late Hereditary Syphilis (Am. Jour. Med. Sci., Jan. 1879); and

Hyde, The Nurse-maid and the Mother of the Syphilitic Child (Chicago Med. Jour. and Exam., Nov. 1878).

GENERAL TREATMENT OF SYPHILIS.

EXPECTANT TREATMENT.—A certain number of cases of syphilis run so mild a course that, even if left to themselves and entirely untreated, they would tend to spontaneous recovery. The observation of such cases has led a few observers to imagine that, the disease being in so many instances mild and benignant, no treatment is required, unless unusual complications should arise. But even in the mildest cases, such symptoms as do arise are, if untreated, apt to persist for much longer periods than if treatment were employed, and patients thus deprived of treatment are apt to grow despondent and dissatisfied. In addition, it must be remembered that cases which may at first appear likely to run a mild course, not infrequently show severe symptoms at a later date.

Considering, also, the fact that all, or nearly all, prejudice against the use of mercury has died out in the profession and among the public, there can exist no reason, in the vast majority of cases, why energetic anti-syphilitic treatment should not be employed vigorously in every case.

HYGIENIC AND GENERAL TONIC TREATMENT.—In order to treat syphilis successfully, careful attention must always be paid to the patient's general condition and surroundings. Bad air, insufficient clothing, and scanty or improper food, often cause great aggravation of symptoms, which, under favorable conditions, would be of comparatively little moment. This is strikingly observed in hospital practice in any of our large cities, where syphilitic patients, brought in from the slums in a deplorable condition, rapidly recuperate under the influence of a carefully regulated diet and regimen. I am accustomed, in many cases where the patient's condition is broken down and depraved, to avoid the employment of specific remedies for a time, even when threatening symptoms are present (unless the brain is attacked), and to begin treatment by the employment of nourishing diet, stimulants, and tonics, and I have not infrequently observed the happiest results from this procedure in cases which had been steadily deteriorating and growing worse under a strongly pushed course of specific medication.

The patient under treatment for syphilis should live regularly, employ simple but nourishing diet, abstain from the free use of stimulants and tobacco, pay attention to the functions of the skin and bowels, and take as much exercise in the fresh air as circumstances will permit. Under the head of regularity of living, the careful restriction of the appetites and, particularly, the sexual desires, must be insisted upon. In nervous syphilis, above all, the consequences of venereal excesses are most deplorable.

Persons who have been accustomed to the use of stimulants should not be deprived of alcohol in every shape, but may be treated with the bitter tinctures, such as the tincture of gentian and the like.

A cheerful disposition on the part of the patient should be cultivated by the physician, not only as assisting the action of the remedies, but as tending to prevent that unfortunate melancholic habit of mind which is known as syphilophobia, and which, when firmly established, is often irremediable. Persons suffering with this delusion fancy themselves incurably saturated with syphilitic poison, and at times, no assertion of his perfect health, given by the physician, will set the patient's mind at rest.¹

Examination of the blood of patients in the early stages of syphilis, shows chloro-anæmia, or a diminution in the proportionate quantity of red blood

¹ Cases have been repeatedly reported of syphilophobic patients having committed suicide.

corpuseles. Iron is, therefore, called for in many cases, either alone or combined with the specific remedies. In the majority of cases, the tincture of the chloride is the most available form of ferruginous medication, although I frequently use the dried sulphate of iron, or the tartrate, in the form of wine of iron; the tincture may be occasionally used alone, or more frequently, as with the last two preparations, combined with the specific remedies. The bitters, such as quinine and gentian, are frequently called for, and occasionally the mineral acids may be resorted to in appropriate cases.

SPECIFIC TREATMENT.—The chief remedies in syphilis are the various preparations of mercury and iodine. Although in the discussion of the various manifestations of the affection in the preceding pages, some mention of peculiarly appropriate forms of treatment has been made, it remains in this section to set forth the general principles of the specific treatment of syphilis, and to indicate those preparations and applications which experience has shown to be generally useful in dealing with the various lesions as they may arise.

Mercurial preparations are most generally useful in the earlier stages of syphilis, while the iodides come into play in the later forms. As no hard and fast line can be drawn between the "early" and "late" lesions, commonly so called, so no invariable rules can be laid down for the administration of one class of remedies or another; each case must be treated on its merits, and one or the other remedy, or both together, must be given as the occasion demands.¹

MERCURIALS.—Mercury came into use in the early history of syphilis, and though violently assailed from that time to this, has held its own as an invaluable remedy. Even its abuse in a past generation, when salivation was considered a condition to be aimed at in the treatment of all venereal disease, has never caused it to lose its hold upon the esteem of the profession.

As regards the period at which the administration of mercury should begin, it is now agreed by most syphilographers that nothing is gained by its too early administration. Given on or shortly after the appearance of the initial lesion, its effect is to delay and render irregular the advent of the generalized lesions, without preventing their eventual appearance. An element of confusion is thus introduced into the orderly evolution of the various manifestations, and occasionally the delay in their appearance gives rise to false hopes of a permanent cure, often rudely dispelled by an unexpected outbreak, or perhaps by the transmission of the disease to an innocent person.

It will not do, however, to leave the patient entirely without treatment, and it is better, therefore, when the diagnosis of chancre is made, or even when the existence of the initial lesion of syphilis is suspected, to begin the administration of internal remedies, perhaps iron and quinine, warning the patient at the same time of the probable supervention of general manifestations, but waiting until these actually appear before instituting mercurial treatment.

The choice of the form in which mercury shall be administered is often dependent upon nothing more than personal preference. It must be remembered, however, that the same preparation is not suitable in every case, nor in the same case at different periods, and a trial must often be made of several different preparations before the one best adapted to the case can be selected. When any given preparation seems to lose its effect, it is generally

¹ See Hutchinson, When and how to use Mercury in Syphilis. *Am. Journ. Syph. and Derm.*, vol. v., 1874, p. 112.

better to change it for another rather than to increase the dose to any considerable extent, which might disarrange the stomach or bowels.

The preparations of mercury which I am most in the habit of using are the pil. hydrarg. and the protiodide. The former preparation and the mercury with chalk are the two forms of the drug chiefly employed by Bumstead and Taylor, while the protiodide is preferred by Keyes. Whichever of these preparations is used, it should at the outset be given with caution, since the patient's susceptibility is not generally known before trial, and salivation is to be avoided. The following formula is given by Bumstead and Taylor. I have used it, with or without the opium, in hundreds of cases, and consider it a convenient and practical prescription:—

R.—Pil. hydrarg. gr. xl.
Ferri sulph. exsiccāt. gr. xx.
Ext. opii, gr. v. M.

Divide into twenty pills, one to be taken from two to four times a day.

The following formula for mercury with chalk is given by Bumstead and Taylor:—

R.—Hydrargyri cum creta, gr. xl.
Quiniæ sulphatis, gr. xx. M.

Divide into twenty pills, one of which is to be taken from two to four times a day.

The dose of the protiodide is from one-sixth to one-third of a grain, thrice daily. Given in larger doses than half a grain, it is apt to disagree, and to cause griping and diarrhœa. In order to prevent intestinal irritation, the protiodide may be taken half an hour after eating, or, if necessary, it may be combined with a little opium. The sugar-coated granules, as made by trustworthy pharmacutists, afford a convenient method of administering the protiodide; made as small as the one-fifth of a grain, the dose may be gradually increased and carefully regulated.

The biniodide of mercury is a favorite form of administering the drug with many practitioners, among whom I may mention my friend, Prof. Duhring, whose extensive experience with this preparation in the treatment of syphilitic skin manifestations leads him to think very favorably of it. It may be administered alone, but is more usually combined with the iodide of potassium. The following formula, the time-honored *Sirap Gibert*, is one which I frequently prescribe:—

R.—Hydrargyri biniodidi, gr. j.
Potassii iodidi, ʒj.
Aque, fʒj.
Filter through paper and add
Syrupi simplicis, fʒv. M.

Dose, a tablespoonful.

Some patients object to the cloying sweetness of this preparation, in which case water alone may be employed, or wine of iron may be substituted for part or the whole of the syrup.

Occasionally it is found convenient to separate the mercurial and the iodide of potassium, in which case one may be given while eating, and the other half an hour or more after meals.

The bichloride of mercury is not as frequently employed as formerly; nevertheless it is a good remedy, though it does not generally act as quickly as the other preparations mentioned. I usually prefer to prescribe it in solution, and commonly make use of the formula known as the "liquor of Van Swieten," which is composed as follows:—

Bichloride of mercury, 1 part.
 Water, 900 parts.
 Alcohol, 100 parts.

Dose, a tablespoonful, given in a wineglassful of pure or of sweetened water, according to the taste of the patient.

The bichloride may also be given in one of the bitter infusions, or in combination with the tincture of the chloride of iron, as thus:—

R.—Hydrargyri chloridi corrosivi, gr. ij.
 Tinct. ferri chlor. f℥iv.
 Aquæ, ad f℥iv. M.

Dose, a teaspoonful in a wineglassful of water.

If it is desired to give the bichloride in pill form, the following (Sturgis) is a good combination:—

R.—Hydrarg. chlor. corrosiv. gr. $\frac{1}{16}-\frac{1}{8}$.
 Saponis, q. s. ut fiat pil. una. M.

One thrice daily after meals.

In order to check its action upon the bowels from one-quarter to half a grain of opium may be added to each pill.

General Principles of the Administration of Mercury.—The method of administering mercury, the period during which it is to be given, and the proper average dose of the various preparations, must now be considered.

In former times the object aimed at was to salivate the patient, and, this end once attained, the disease, it was thought, might be considered cured. At the present day salivation is universally regarded as a catastrophe to be avoided, and it only occurs as the result of mischance. Two plans of treatment are usually recommended by modern writers, the treatment by “courses” of mercury, with intervals of rest between the series, and the so-called “tonic,” or continuous treatment by small doses. The latter plan has been brought into prominence of late years by the writings of Keyes, of New York.¹

The preparation usually employed by Keyes is the protiodide of mercury, and he prefers the accurately made French granules of Garnier and Lamoureux, each of which contains exactly one-sixth of a grain, although several American-made gelatine-coated pills are equally good. In the rare cases in which the French granules cause griping, Keyes recommends blue pill, according to the formula given above, only in half grain doses, with a quarter of a grain of the dried sulphate of iron.

To bring a patient under the tonic treatment, if there be time, Keyes recommends the following course:—

“Let him take one standard dose of mercurial (one granule of the protiodide, for example) after each meal, for two or three days. On the fourth day one extra standard dose is added at the mid-day meal; now four standard doses (granules) are taken daily, and this is to be continued for three days [when a fifth is added].

“On the succeeding fourth day another standard dose is added, two standard doses being now taken after each meal—six granules a day.”

The dose is thus increased every third or fourth day, the patient living regularly, and taking bland food until the gums are touched, or until diarrhœa and griping are experienced. When the symptoms are urgent, or when for

¹ (a) The Effect of Small Doses of Mercury in modifying the number of the Red Blood Corpuscles in Syphilis. (Am. Journ. Med. Sci., Jan. 1876.) (b) The Internal Treatment of Syphilis. An essay read before the International Medical Congress in Philadelphia in 1876. (Transactions of Int. Med. Congress, Phila., 1877.) (c) Tonic Treatment of Syphilis. New York, 1877. (d) The Venereal Diseases. New York, 1880.

any other reason it is desirable to make a rapid impression, fumigation, inunction, or the administration of $\frac{1}{16}$ grain of the corrosive chloride in tincture of bark, taken diluted after meals, may be employed, and then, when the urgent symptoms have fairly declined, all medication may be suspended for a week or two, after which the course sketched above may be regularly instituted.

"When a dose of six, nine, or even twelve granules a day, in some cases, has been reached, it will produce a very positive attack of diarrhœa, with pain in the intestines, and occasionally at the same time the breath will begin to have the mercurial fetor, and the livid line will begin to show faintly along the edge of the gums, while the teeth themselves become a little sensitive on being snapped sharply together, and the saliva flows more freely."

Diarrhœa and griping, however, are more apt to be met with in using the protiodide than are the mouth symptoms.

When either set of symptoms occurs, the patient is taking what Dr. Keyes calls his "full dose," which is anything but tonic, and which is only to be kept up, with the aid of bland food and a little opium, until the urgent symptoms are overcome. It is then dropped to one-half, which is the "tonic dose," and may be continued steadily during several years without injury to the patient, indeed to his advantage as regards his general condition. When, however, the syphilitic symptoms have subsided, a still less quantity, perhaps one-third of the "full dose," is required. This dose is also tonic, and is to be persisted in daily, year in and year out, alterations being made from time to time, according to the varied necessities of the particular case.

During the existence of moderate symptoms the tonic dose may be continued, but if special outbreaks occur, more active measures, in the shape of increased doses, fumigations, etc., may be resorted to temporarily. When the period of late lesions arrives, if an outbreak occurs, the iodides are to be used temporarily, and the tonic course again resorted to when the emergency is past.

As regards the period during which the tonic course should be given, this must vary in different cases. About three years is a full course for most people, while two years and a half, or even two years, answers well enough in some cases. Six months—or better, an entire year—of immunity from symptoms is desirable, before the tonic treatment is stopped.

I have given Dr. Keyes's plan of treatment at some length, both because it is not as well known as the older plans, and because it has commended itself to me, after some years of personal experience, as decidedly the best and most rational. It is often difficult to induce patients to follow out such a prolonged course of treatment. The symptoms once fairly gone, the patient gradually forgets the serious nature of the affection from which he has suffered, and this diminishes in importance in his mind while the continual dosing becomes more and more irksome. For this reason I have frequently failed in inducing patients to prolong the treatment for any considerable length of time after the disappearance of all visible signs of the disease. I have, however, succeeded in some instances; and even when the course of treatment has not been prolonged to the extent which I should have desired, the effect has been so satisfactory that I employ this to the exclusion of all other methods.

Salivation.—Although mercury is rarely given in large doses at the present time, and salivation is consequently of very unusual occurrence, yet this complication does occasionally arise, owing to some idiosyncrasy of the patient, or to some other cause, and it must be dealt with and relieved as quickly

as possible. It is a good plan to employ a mouth-wash during the administration of mercurials, such as the following:—

R.—Potassii chlorat. \mathfrak{Zj} .
Aqua, $\mathfrak{f}\mathfrak{Z}\mathfrak{vj}$. M.

Sig.—Use as a mouth-wash three or four times daily.

This may be combined with an aromatic astringent, as in the following elegant preparation:—

Chlorate of potassium, \mathfrak{Zss} .
“Eau de Botot,” $\mathfrak{f}\mathfrak{Zij}$.

A teaspoonful in a wineglassful of water, as a gargle.

If salivation has actually set in when the patient is seen, the first of these formulæ may be administered internally in teaspoonful doses four or five times daily, or belladonna may be given as in the following (Sturgis):—

R.—Tinct. belladonnæ, $\mathfrak{f}\mathfrak{Ziv}$.
Aqua, $\mathfrak{f}\mathfrak{Zij}$. M.

Sig.—Teaspoonful four times a day in water.

Atropia may be preferred in severe cases:—

R.—Atropiæ sulphat. gr. $\mathfrak{r}\mathfrak{ss}$.
Alcoholis, $\mathfrak{f}\mathfrak{Zss}$.
Aqua, q. s. ad $\mathfrak{f}\mathfrak{Zij}$. M.

Sig.—Teaspoonful three or four times daily.

The chlorate of potassium may be employed simultaneously. When the gums are spongy, and the teeth are loosened and appear ready to drop out, nitric acid should be given internally and locally.

R.—Acid. nitric. dil. $\mathfrak{f}\mathfrak{Ziv}$.
Aqua, $\mathfrak{f}\mathfrak{Zij}$. M.

Sig.—Teaspoonful four times a day in water; also use locally, diluted with water.

Keyes recommends chlorate of potassium, in solution in cold tea, about one or two drachms to the pint, with a scruple of carbolic acid. The carbolic acid is particularly called for by the fetor of the breath, and to sweeten the foul secretions of the mouth. He also recommends the employment of hypodermic injections of a solution of atropia (gr. \mathfrak{j} to $\mathfrak{f}\mathfrak{Zj}$), five minims of which may be thrown under the skin—the influence on the pupil being watched, and the dose repeated every four or six hours until the pupils are widely dilated. The effect of this remedy upon the salivary secretion, says Dr. Keyes, is often very prompt, and the general influence over salivation quite marked.

Sulphide of calcium, in from one-tenth to one-fifth grain doses every three hours, is a remedy which has been highly commended, but which, in my experience, has not proved very satisfactory.

Fumigation.—Mercurial fumigation, formerly much employed as a remedial agent in syphilis, fell for a time into disuse, but has been revived again of late years, chiefly through the efforts of Mr. Langston Parker, of Birmingham, England, and more lately through those of Mr. Henry Lee. The vapor may be generated from metallic mercury, calomel, mercury with chalk, the bisulphuret, the gray oxide, or the binoxide. The amount to be used varies from twenty to one hundred and twenty grains, according to the effect desired.

Calomel is the best agent for ordinary employment, and the simpler the apparatus used the better. Water is usually vaporized simultaneously with the mercurial. Bumstead and Taylor give two cuts illustrating the best apparatus for vaporizing by means of an alcohol lamp or by gas. An

extemporaneous apparatus can readily be arranged, or the corrosive sublimate may be dissolved in water, and subjected to ebullition by any ordinary process. A simple apparatus may be made by bending a piece of tin into a table, or a brick may be heated, and the calomel sprinkled upon its surface, a pail of boiling water being at the same time placed by its side under the chair on which the patient sits. The patient should be clothed in a long sleeveless flannel gown of ample dimensions, over which should be placed a somewhat similar garment of India-rubber "Mackintosh" cloth. He should sit upon a cane-seated chair, under which the fumigating apparatus should be placed, the flannel gown and Mackintosh covering the whole seat and apparatus. The lamp being lit, vapor of water is first generated, enveloping the patient in a steam which soon provokes a free perspiration. As the temperature of the apparatus rises, the calomel also becomes vaporized, and is readily absorbed by the skin. As soon as the mercury has disappeared, the light is put out, and the patient remains seated and covered with his bath-clothes until the body begins to cool slightly. The rubber coat is then removed, and the patient is wrapped in blankets until all perspiration has ceased, and the body has become cool and tolerably dry, when he may put on his ordinary clothes again. But it is better to give the bath at bedtime, and let the patient retire immediately, sleeping in his flannel gown.

The fumigation treatment is one which it is not always easy to employ in private practice, but it is I think the best and most efficient form of medication when there is an extensive and stubborn eruption of the skin which fails to yield readily to internal treatment, when the greatest rapidity of cure is desirable, or in cases where the patient's stomach is weak, and it is desirable to save it in every way. Occasionally patients complain of a feeling of debility and headache, which may be obviated by using less steam, and by diminishing the length of the bath. Diarrhœa, and occasionally, though rarely, salivation, are also observed in some cases. The frequency of the baths should be determined by the strength of the patient and by the degree of mercurial action desired. In early syphilis, when the patient's strength is fair, the bath may be given every night, but in late syphilis, when a rapid effect is not required and when patients are debilitated, two or three times a week is sufficiently often.¹

Inunction.—Inunction, though an uncleanly and to many persons repugnant form of treatment, is one which is very efficient, and in some cases invaluable, as a means of rapidly impressing the system, or of producing the effects of mercury while saving the digestive organs. The plan formerly employed, and still not uncommonly resorted to, is that of rubbing a quantity of unguentum hydrargyri into various portions of the integument in succession. Taking the groin, for instance, on the first day, and rubbing a piece of the ointment the size of a hazel-nut or a small walnut thoroughly into the skin, the other groin is selected for the next day's operation, then one axilla, and the other, etc., until the surface is entirely gone over. The constant state of greasiness thus produced is very disagreeable, and almost intolerable to a fastidious person, and the evil is only mitigated in part by the use of the more elegant preparations of the oleate of mercury. For this reason I have of late years usually employed the following method, which was first brought to my notice by one of Dr. Sturgis's writings. The patient bathes the feet thoroughly in hot water the night on which the first inunction is made, when half a drachm of oleate of mercury of 20 per cent. strength is rubbed briskly into

¹ A very good article on mercurial fumigations is that by Prof. D. W. Yandell, published in the American Practitioner, Louisville, Sept. 1877.

the sole of the right foot; this is repeated the next night on the left foot, and so on alternate nights the right and left foot are anointed with half a drachm of the preparation. This may be increased to a drachm or more if the patient stands the mercurial well. The stockings should be worn continuously night and day for a week, at the expiration of which time the feet may be thoroughly cleansed with hot water and soap, and the treatment suspended for a few days, and then recommenced. The unguentum hydrargyri may be used instead of the oleate of mercury, and in fact I commonly prefer it to the more elegant preparation, because it seems to me that it is absorbed more readily.

During the inunction treatment, the condition of the mouth and gums is to be carefully looked after, and it is well to use one of the astringent washes given above.

Mercurial suppositories, composed of about half a drachm of mercurial ointment and a sufficient quantity of butter of cacao, introduced into the rectum at night, have been employed. I have never used them, and as they give rise to local irritation, I think they are not to be recommended.

Hypodermic Injection.—The hypodermic injection of mercurials for the treatment of syphilis has been highly recommended by a number of European authorities,¹ but has never found extensive employment in this country, since the injections are followed by considerable pain, often lasting for some hours, and since, in spite of every precaution, abscesses will occasionally form at the point of insertion of the needle.

Bumstead and Taylor recommend the following formula:—

R.—Hydrarg. chlor. corros. gr. iv.
Glycerinæ, fʒj.
Aque destillat, fʒvj. M.

Twelve drops of this solution contain about one-eighth of a grain of the sublimate, and are used for each injection.

In employing mercury by hypodermic injection, a comparatively insensitive portion of the skin should be selected, and a locality where abscesses are not very apt to form. The infrascapular regions, the loins, and the upper portions of the nates are the best points for the introduction of the needle. As it is supposed that mercury exerts a local action in hastening the disappearance of the lesions, it may in some cases be advisable to employ the injections in or near affected parts. The same syringe should never be used on syphilitic and non-syphilitic persons. The point of the needle should be kept sharp and polished.

The hypodermic method is objected to by patients in private practice, and it is best to confine its employment to such cases as from some cause may contra-indicate the use of other methods of treatment, or where it is desirable to get the full effect of the drug with great rapidity. Patients are unquestionably relieved from external symptoms with more rapidity by this method than by other modes of treatment.

IODINE AND ITS COMPOUNDS.—Iodine and its compounds are ordinarily useful in direct ratio to the duration of the disease. Their action on the early

¹ See Wigglesworth, Subcutaneous injection of corrosive sublimate in syphilis (Boston Med. and Surg. Jour., Aug. 26, and Sept. 2, 1869); Lewin, Behandlung der Syphilis mit subcutaner Sublimat-injection. Berlin, 1879; Staub, Traitement de la Syph. par les Injections Hypodermiques de Subliné à l'état de Solution Chloro-albumineuse. Paris, 1872; Bamberger (Zeit. d. Öest. Ap. Ver., 1876, 147, 177; and New Remedies, New York, 1876, pp. 167, 175); Günz, Ueber subcutane Injection mit Bicyanuretum Hydrargyri bei syphilitischen Erkrankungen (Wien. med. Presse, 1880).

lesions of syphilis is slight, but on the later lesions, especially gummatous tumors, affections of the bones, brain-troubles, etc., the influence of iodine is sometimes almost magical. The iodine compounds alone do not, however, as a general thing, possess the power of permanently removing the lesions which they cause to disappear so quickly, and mercury must usually be resorted to in order to obtain a permanently favorable result.

The dose of the iodides must vary greatly with different cases. In mild cases, the iodide of potassium—which may be taken as a representative of the class—may be given in doses of from two or three to eight or ten grains three times a day; but in brain-troubles, it is sometimes necessary to give the remedy immediately in large doses, and frequently as much as an ounce or more is taken thus by the patient in the course of twenty-four hours.

The iodide of potassium may be given in five-grain compressed pills or in solution. I think it less apt to disagree in the latter form. As it is very soluble in water, this fluid may be used as a menstruum with or without any adjuvant. I commonly give the iodide of potassium in water alone, as I think that the various flavoring substances which are employed, often fail to do more than partially disguise the nauseous metallic taste of the drug, and not infrequently give a strange and repulsive flavor to the mixture. The following formula is one of the best when it is desired to hide the taste and appearance of the drug, as far as may be, and when a ferruginous tonic is required:—

R.—Potassii iodidi, \mathfrak{z} vss.

Vini ferri, $\mathfrak{f}\mathfrak{z}$ iv. M.

A teaspoonful contains ten grains of the iodide of potassium.

The action of iodide of potassium appears, I think, in some cases, to be increased by the addition of the carbonate of ammonium, as in the following formula:—

R.—Potassii iodidi, \mathfrak{z} ijj.

Ammonii carbonat. \mathfrak{z} iss.

Vini ferri, $\mathfrak{r}\mathfrak{z}$ iv. M.

A teaspoonful contains six grains of iodide of potassium and three grains of carbonate of ammonium.

Iodide of potassium agrees best when given from half an hour to an hour after eating. Griping, which is sometimes experienced, may often be obviated by the addition of a syrup containing tannic acid, added in substance, or as it occurs in cinchona or in orange peel, as in this formula:—

R.—Potassii iodidi, \mathfrak{z} j.

Syr. aurantii corticis, $\mathfrak{f}\mathfrak{z}$ vj. M.

Dose, a tablespoonful, containing five grains of iodide of potassium.

When giving iodide of potassium in large doses—and, in fact, when giving it in any case in which it is found to have a tendency to disorder the stomach—I add Vichy water, as suggested, I think, by Keyes, directing the patient to pour into a small tumbler the dose desired to be taken of the simple aqueous solution of the iodide, and then to turn in a wineglassful or more of artificial Vichy water, from a portable fountain, such as is sold in the shops. This combination makes the iodide easier to take, and causes it to agree better with weak stomachs.

The usual dose of iodide of potassium is from five to ten grains thrice daily, but this may, and often should be, surpassed in serious cases, especially when threatening symptoms show themselves. Symptoms will often yield to drachm doses which have stubbornly resisted ten-grain doses, and no case should be pronounced intractable to the iodide until this has been pushed to large amounts.

The iodides of sodium and of ammonium may occasionally be substituted for the iodide of potassium, where they agree better with the patient, or where a change is for any reason desirable. Iodide of iron is not very efficient, but may occasionally be employed as a tonic or succedaneum, or in the case of children.

Iodine, in the form of the tincture, may occasionally be employed when the iodides disturb the stomach. Keyes suggests the administration of the tincture in doses of ten drops in a tablespoonful or more of starch-water, and increased up to eighty drops in a claret-glass of the diluting fluid.

The contra-indications to the use of iodine in any of its forms are, acute or chronic inflammations of the digestive organs, plethora, and a predisposition to hemorrhages. Acute catarrh sometimes comes on at the very beginning of a course of iodide of potassium; the patient sneezes and coughs, the eyes grow red and watery, the nose runs, and sometimes there is a severe headache across the brow. Very often the patient gets accustomed to the remedy, and these symptoms wear away, while in other cases, a temporary stoppage of the iodide, and a beginning again in smaller doses, gradually increased, will enable him to take the medicine with impunity; in other cases, however, the idiosyncrasy is unconquerable, and the drug must be stopped. The headache may sometimes be remedied by adding a diuretic, a little bromide of potassium, or a small quantity of opium, to the iodide.

The iodides produce, at times, a variety of eruptions, commonly acneiform or hemorrhagic, but occasionally closely resembling the lesions of syphilis.¹ The addition of small quantities of arsenic (5 to 10 minims of Fowler's solution) to the dose of the iodide will often prevent the appearance of these eruptions.

Bright's disease of the kidneys is said to be produced in some cases by the prolonged use of iodide of potassium, but the assertion has never been supported by entirely adequate evidence. Dr. I. Edmondson Atkinson, of Baltimore, in a recent paper on the subject,² after reviewing the cases and arguments brought forward on one side or the other of the question, and comparing them with the results of his own experience, concludes that while the occurrence of severe alterations of the kidneys as the effect of iodide of potassium is probable in rare cases, yet that there is no constant tendency on the part of the kidneys to resent its employment.

MIXED TREATMENT.—The combination of mercury and iodine has been a favorite form of administering these remedies for many years. It has its disadvantages, however, and should never be resorted to without reason. Many practitioners prescribe mercury and iodide of potassium in every case of syphilis, or even in every suspected case, upon the principle of the sportsman who shuts his eyes and fires both barrels of his gun, hoping that something will be hit somewhere. But in the earlier stages of syphilitic disease mercury is not only a sufficient, but is the best remedy, and iodide of potassium, if added to it, not only does not hasten the cure, but by tending to upset the stomach and interfere with digestion, may lose the surgeon the aid of this important organ just when it is most required, to digest the food with which the patient's strength is to be kept up, and to absorb the drugs which cannot be administered conveniently in any other way.

The "mixed treatment" therefore should be reserved for stubborn cases where one or the other remedy has failed, or where, as in late syphilis, the appearance

¹ For a description of these, see a paper, by the author, on Medicinal Eruptions, read before the American Dermatological Association. (Archives of Dermatology, Oct. 1880.)

² May Iodide of Potassium excite Bright's Disease? Amer. Journ. Med. Sci., July, 1881.

of gummatous lesions calls for direct medication to resolve them, while at the same time the tonic treatment of mercury is to be kept up.

Among the various forms in which iodide of potassium and mercury may be administered in combination, the "Sirop Gibert" (the formula for which has already been given), is, I think, as good as any. Keyes recommends the following:—

R.—Hydrarg. biniodid. gr. ss ad j.
Potassii iodidi, ℥ij.
Ammonii iodidi, ℥ss.
Syr. aurantii corticis, f℥ij.
Tinet. aurantii corticis, f℥j.
Aquæ destillatæ, q. s. ad f℥iv. M.

Dose, a teaspoonful, containing $\frac{1}{84}$ grain to a $\frac{1}{32}$ grain of the biniodide of mercury, and four grains of the iodide of potassium.

When it is desired to give the corrosive chloride of mercury combined with iodide of potassium, this formula may be employed:—

R.—Hydrarg. chlor. corrosiv. gr. j.
Potass. iodid. ℥iiss.
Vini ferri, f℥iv. M.

Dose, a teaspoonful.

I sometimes give protiodide of mercury pills at the same time as the solution of iodide of potassium, or the pills before and the iodide after meals. Another method of employing the "mixed treatment" is to prescribe mercury by inunction, and the iodide of potassium internally.

LOCAL TREATMENT.—I have said something about the local treatment of the various syphilitic affections when dealing with the latter in the earlier portion of this article. At the risk of some repetition, however, I think it well to give some general suggestions and formulæ for the treatment of such lesions as can be reached by local agencies.

The local treatment of chancre has already been sufficiently described, as have also the local applications employed in alopecia, and in the lesions of the mucous membranes. (See pages 368, 402, 404.) I may add here, however, a very elegant, and also a quite useful formula for a mouth wash, to be used by way of prophylaxis in the earlier months of syphilis:—

Eau de Botot, f℥vj.
Tincture of cochlearia, f℥iiss.
Tincture of cinchona, f℥ij.
Tincture of catechu, f℥j.
Tincture of benzoin, f℥ss.

A small quantity is mixed with water and used as a gargle morning and evening, and after meals.

The necessity of absolute cleanliness need hardly be mentioned. Where there is any discharge, whether from a suppurating lesion upon the skin, or from any of the cavities of the body, that discharge should never be allowed to accumulate. There is no "laudable" pus in syphilis: the discharges are all poisonous. In addition to the free use of soap and water, disinfectant washes, such as Labarraque's solution of chlorinated soda, may be employed, or those containing carbolic acid; such as the following:—

R.—Acid. carbol. f℥iiss.
Glycerinæ, f℥ss.
Aquæ, ad. f℥viij. M.

To be used in a state of more or less dilution, according to the locality.

Labarraque's solution, diluted with from three to six times its bulk of water, forms a good disinfectant wash in ozaena.

Of other washes which may be employed in suppurating lesions of the skin, to stimulate to healthy action, *lotio nigra* or black wash, and *lotio flava* or yellow wash, are the most generally useful. The latter is much the more stimulating of the two, and forms an admirable dressing for suppurating gummata and tubercular ulcerative lesions.

A still stronger, almost caustic, wash is the following:—

R.—Hydrarg. chlor. corros. gr. iv.
Alcoholis, f̄ʒj. M.

This should be used with caution on delicate surfaces, but is an admirable means of hastening the cure of moist papules. It may be rubbed without fear into the palm and sole, where the epidermis is thick.

Certain powders come into play in the treatment of moist and suppurating syphilitic lesions, prominent among which is iodoform. The disagreeable odor of this drug almost forbids its use in private practice, and its employment in syphilis is now so well known that the individual who goes about smelling of it is a marked man, and might almost as well bear a placard about his neck worded "syphilis." I have observed such persons in passing them on the street. For this reason the drug should not be employed except in case of dire necessity, that is, in late, deep, or serpiginous ulcerative lesions, when we must strain every nerve even to keep the patient from relapsing and going back. In hospital practice iodoform may be used freely and with great advantage. When it gives pain, as it sometimes does, although ordinarily its effect is just the reverse—distinctly anæsthetic—the iodoform may be mixed with two or three parts of tannic acid powder. The following snuff is recommended in the nasal catarrh of syphilis:—

R.—Pulv. iodoformi,
Pulv. camphoræ, āā ʒj.
Pulv. acaciæ, ʒij. M.

Other powders are those of calomel, and the powder of savin and burnt alum, used in vegetating syphilodermata after these have been carefully cleansed with Labarraque's solution. The latter is composed as follows:—

R.—Pulv. sabinae, ʒj.
Pulv. aluminis, ʒiv. M.

Tannic acid and chromic acid are also occasionally employed in powdered form. The latter should be used with caution, and only when a distinctly caustic effect is desired.

The ointments employed in the local treatment of syphilitic lesions are very numerous. A comparatively small number, however, are in reality sufficient, and all beyond this are required only in the interest of variety or individual fancy, or occasionally to meet particular indications.

The early generalized skin eruptions require no local treatment by ointments. The erythematous syphiloderm is unaffected by outward applications. The papular and pustular eruptions, as these occur upon the face, may, however, be treated locally with a view to hasten their removal, and ointments may also be advantageously used for the speedier resolution of moist papules about the genitalia and anus.

Among the milder preparations, ammoniated mercury ointment may be employed, as thus:—

R.—Hydrarg. ammoniat. gr. xx-xxx.
Ung. aquæ rosæ, ʒj. M.

Calomel may also be used in ointment of half the above strength, that is, from ten to twenty grains to the ounce.

A very good, drying ointment, which may be used in moist papules or small ulcers, is the following:—

R.—Hydrarg. chlor. mitis, gr. x-xxx.
Pulv. zinci oxidi, ℥j.
Ung. aquæ rosæ, ℥j. M.

Oleate of mercury in the strength of from five to ten per cent. is a very good application in the dry and scaly eruptions, particularly those occurring on the palms and soles, while an ointment like the following may often be used with advantage in ulcerative lesions:—

R.—Hydrarg. oleat. (5-20 per cent.),
Vaselinī, āā ℥ss. M.

I rarely employ the unguentum hydrargyri as a local application, because it is a dirty looking substance, and no more efficient than the white precipitate ointment given above.

In addition to the plasters which have been mentioned in previous parts of this article, the following may be recommended as particularly useful in those chronic and indurated scaly eruptions of the palm which are so rebellious to treatment of any kind:—

R.—Hydrargyri, ℥j.
Terebinthinæ, ℥j.
Emplast. plumbi, ℥ijss.
Resinæ, ℥ss. M.

This makes an exceedingly tenacious plaster which may be applied to the palm, previously softened by repeated dipping in very hot water. It may be rubbed in, or, better, spread upon one or more strips of muslin arranged so as to wrinkle as little as possible, and changed once a day or oftener. I have found this to succeed in obstinate cases when all else has failed.

Tuberculous and gummato-tuberculous ulcers of the leg are frequently benefited by strapping, bandaging, elastic stockings, etc., and when, as is sometimes the case, they tend to erysipelas-like inflammation, cold lead-water on cloths or in poultices should be temporarily employed. Finally, let me once more urge the necessity of extreme cleanliness and the removal of all crusts, scales, and discharge, before the application of local treatment of any kind.

SYPHILIS IN ITS RELATIONS TO MARRIAGE.

Physicians are not infrequently consulted by individuals who have contracted syphilis, or who believe themselves to have contracted this affection, regarding their intended marriage; and it is of great importance that the answer given should not be misleading, for the health and happiness of two persons at least may be affected by it, and the consequences of a mistake may influence an unborn generation for evil.

It will not do, on the one hand, to sternly repel such persons with the simple and categorical refusal to give medical sanction to the intended union. Sometimes this is done when the history of infection dates back to a remote past, and when no symptoms of syphilis have shown themselves for years. Now and then even the suspicion of the patient's having had syphilis is sufficient to induce his physician to forbid the banns.

The misery and immorality to which such restriction almost necessarily tends to give rise, should cause the conscientious physician to hesitate before

washing his hands lightly of the whole business by declining to sanction the marriage of a former or of a presumptive syphilitic.

On the other hand, to sanction marriage when the syphilitic disease is still active in the system, even although it does not for the moment show itself by any outward sign, is to lure an unsuspecting victim to the committal of a crime against himself and others, of which he cannot appreciate the consequences.

It therefore behooves the physician who is called upon to pronounce an opinion in such a case to examine the patient with the utmost care, to go into the history of the case, with minute examination of every point which can throw light upon the presence or course of pre-existent syphilitic disease, and not to pronounce his opinion until fully satisfied of the exact condition of his patient.

As formulated by Langlebert,¹ the various cases which present themselves may be grouped under one or another of the following heads: (1) An individual² previously without syphilitic disease shows one or more lesions, apparently chaneroids, and asks whether he may marry, and how soon. (2) An individual having had six months or longer previously one or more venereal sores, as to the character of which he cannot speak positively, but for which mercurial treatment was followed, asks the same question as (1). (3) An individual who is or has been the subject of an infecting sore (chancre), afterwards followed by generalized symptoms, which may or may not now show themselves, asks the same question as (1). (4) A man marries after having had syphilis, but at so remotely previous a date that there is reason to hope that he will show no future signs of the disease—what has he to fear for his future offspring? (5) An individual marries, having present syphilitic manifestations, or contracts syphilis after his marriage—what shall be done to avoid, or at least to lessen as much as possible, the consequences of his misconduct?

Under the first head, when a patient displays one or more venereal sores resembling chaneroids, and asks how soon he may marry, the advice should be given to wait for six months. If by the end of this time no generalized lesions have made their appearance, the marriage may be consummated without fear.³ For, as has been shown in the earlier portion of this article, the longest period of incubation elapsing between the appearance of the initial lesion and the explosion of the general symptoms, does not exceed six months. Of course it is understood that during this period the patient should submit himself to the frequent inspection of his physician, for otherwise the earlier general symptoms may pass unnoticed. In addition, the patient should be directed to examine himself carefully from day to day, and especially to look for the erythematous rash, which so often appears and disappears without having been perceived, as well as for papules, mucous patches of the mouth, etc., crusted lesions of the scalp, and enlargement of the cervical glands.

Under the second head, where a person who has had a suspicious sore or sores six months or more previously, for which mercurial treatment has been fol-

¹ *La Syphilis dans ses Rapports avec le Mariage.* Paris, 1875.

² Women so rarely present themselves for examination and opinion that I consider here the case of men only. There is, of course, little difference between the sexes regarding the manifestation of the disease, excepting the far greater difficulty of finding whether or no a woman has had a chancre. I fail in ninety-nine cases out of a hundred to get any history of an initial lesion on the genitalia in women, though I rarely meet with cases where there is any apparent intent or desire to deceive.

³ Under such serious circumstances no reliance can or should be placed upon the classical descriptions of chancre and chaneroid. In these cases the chaneroid is the lesion which is found not to be followed by general syphilis, after six months of careful watching, and no decision can be arrived at until the expiration of this period.

lowed, asks if he may marry, an element of great uncertainty is introduced into the question by the course of treatment which the patient has undergone. For, as is known, mercury given between the appearance of the initial lesion and the advent of general symptoms, has the power to adjourn the appearance of the latter without preventing their ultimate manifestation.¹

In these cases the physician should go very carefully into the history of the patient, and should endeavor to extricate from his answers some data upon which to base a diagnosis. Failing this, a postponement for at least three months must be enjoined, the patient remaining under observation meantime, and, of course, no treatment being employed. The following scheme gives a guide to the questions which should be asked in eliciting the history of former syphilitic disease:—

SCHEME FOR THE EXAMINATION OF PERSONS SUPPOSED TO HAVE CONTRACTED SYPHILIS.²

- (1) The individual has had venereal sores (chancres).
- (2) Ascertain precisely the date at which these sores were contracted. Were there one or more? In the latter case, did they come out simultaneously or consecutively?
- (3) Supposing but a single sore to have existed, what was its seat, its form, its dimensions? How long a time elapsed between the date of supposed exposure and that of the appearance of the sore? Was it soft or indurated?
- (4) Examine the point indicated as having been the seat of the sore in question. Do not forget that the specific induration may last a long time after the sore has healed; that in some cases it may be noticeable even after some years. Remember also that the cicatrix of chancre, when it occurs upon the skin, as on the outside of the prepuce, may present a characteristic bronze tint, which disappears very slowly.³
- (5) What took place in the neighboring lymphatic ganglia? Were the glands swollen at any time? If so, were there a number in the groin (supposing, of course, that the suspicious sore was on the genitalia), on one or on both sides, a hard and indolent group of nodules; or did the glandular involvement take the form of a red, painful, inflammatory tumor, having a single ganglion as its centre?
- (6) In the latter case, did the ganglionic tumor suppurate, or did it terminate by resolution? If it suppurated, did the opening by which it discharged heal up promptly, or did it grow larger and itself become a virulent sore?
- (7) Examine the inguinal regions, where possibly the vestiges of a specific adenopathy may still be found, persisting, as it sometimes does, for months and years after the initial lesion has disappeared.
- (8) If the patient has had a suppurating bubo, the cicatrix should be recognizable, and should show by its extent whether the suppurative opening had closed quickly or whether there had been a virulent open sore. In the latter case it is almost certain that general infection has not taken place.
- (9) Inquire how long the sore or sores persisted, what treatment was followed, and what physician attended the patient. The treatment of a competent physician will, of course, throw light upon the nature of the disease. (Unfortunately, too few physicians are competent to interpret any but the plainest symptoms of syphilis with certainty, while too many give anti-syphilitic treatment in all doubtful cases, of whatever nature. Too much reliance must not, therefore, be placed upon the answer to this question.)
- (10) What followed the sores in question? Does the patient remember to have experienced weakness, fatigue, or pains in the head or limbs, worst at night, during the three months previous?
- (11) Has the patient observed the appearance of a rash, coming out in small, reddish

¹ This is not admitted by all syphilographers, but statistics show, I think, conclusively, that the view here taken is correct.

² This scheme is founded on the one given by Langlebert, in his work already quoted.

³ See Léon Montaz, *Recherches sur la Trace Indélébile du Chancre Syphilitique, ses Caractères*. Paris, 1880.

patches, or round, red, flat, lentil-sized pimples, over the chest, abdomen, and forearms, unaccompanied by any sensation?

(12) Has the patient had, about the same time or a little later, certain grayish patches, with or without ulceration in the throat, on the lips, or on the tongue? (I find patients call these either simply "sores" or "fever-blisters," "cankers," or "ulcerated sore throat;" they are among the most constant symptoms noted and remembered by patients when questioned as to their previous history.) Has the hair thinned or fallen out? Have there been any lentil-sized blackish crusts in the scalp at different points? Have the mastoid or cervical lymphatic ganglia been enlarged at any time, or are they now?

(13) Examine by palpation the occipital region, where there may possibly still be found some ganglionic enlargement; these enlarged glands sometimes persist long after the disappearance of other syphilitic symptoms.

(14) Examine the hair of the scalp: observe if this is thin, especially in the occipital and temporal regions; if it preserves its natural suppleness, or if it has become dry and harsh; also see if there are any cicatrices, or small white patches, deprived of hair, here and there.

(15) Examine the throat. If the tonsils and velum palati have been the seat of ulcerated mucous patches—a symptom rarely lacking in early generalized syphilis—the indelible vestige of these lesions can generally be recognized. The mucous membrane, instead of being smooth as it ordinarily is, presents an irregular surface of a rugous and shagreen-like appearance; the edges of the velum and half arches have lost the sharpness of their contour; they are rough and irregular, with more or less deep indentations. This symptom has only a relative value, since cauterization for any other affection of the fauces will produce the same effect. It should have weight as corroborative evidence, however, when it is present.

(16) It should be remembered that with many persons who have had syphilitic symptoms, even long previously, the lips, the buccal mucous membrane, and particularly the edges and point of the tongue, show small whitish patches of a roundish or irregular contour. These patches are very persistent, and when present furnish very strong presumptive evidence of former syphilis.

(17) Examine the body, and particularly the back, shoulders, and legs, to see if there are not some cicatrices of former pustules. The scars are usually rounded, reticulated, and sharply circumscribed, this feature serving to distinguish them from burns; the latter are always more or less irregular. (Furuncles and acne pustules often have cicatrices quite undistinguishable from those of syphilis; the latter are very common over the back and shoulders, but are rarely found on the arms or legs.) The chest, the abdominal region, the lower limbs, the palms of the hands, and the soles of the feet may likewise present some spots or macules, with or without a depressed surface, their yellowish or coppery tint showing their age to a certain extent, being darker the more recently the lesions have existed.

(18) The patches of *tinea versicolor* found on the trunk are sometimes taken for the erythematous syphiloderm, but a moment's inquiry will show them to have lasted months or years, while the syphiloderm is acute and comparatively transient. The same may be said of the pigmented macules left after acne in dark-skinned persons. These will be found on inquiry to be connected with lesions often dating back to puberty.

As to the third question, whether an individual who has had chancre, followed by subsequent generalized symptoms, may marry; of course, the answer must be negative if the symptoms are still manifest. But if they have disappeared months or years ago, then the question becomes more difficult to answer, and the first problem to resolve is this: is syphilis curable? Without going into that question from a general point of view, I do not hesitate to say that for our present purpose syphilis is curable.

Whether, however, any given case can be said definitely to be cured at a stated time, is a different question. And yet some such statement must be made if the patient is to be authorized to marry.

Mild cases of syphilis, when the early symptoms follow one another at a normal interval and in a benign form, are not apt to relapse. The disease

may be said in these cases to run a definite course, and to exhaust itself in the course of perhaps eighteen months or so, on an average, under judicious treatment. Now and then some slight localized eruption may appear subsequently, but in a majority of cases no lesions which can be called contagious make their appearance. While it is true that mild early symptoms do not insure the patient against the occurrence of late visceral lesions, yet a case of benign syphilis which has been carefully treated is not one where wife or children are apt to suffer if the patient allows a sufficient time to elapse after the appearance of the last lesions, before marrying. In the few cases of this kind which I have had under complete control from the beginning, I have permitted marriage after eighteen months of treatment, followed by from six months to a year of immunity, and I have followed up the history of several persons thus permitted to marry, and have known them to procreate healthy children.

But even benign syphilis, if not treated at an early period, and thoroughly, tends to relapse, and I should not be inclined to authorize marriage in a patient, particularly a woman, who had taken mercury irregularly, and who had suffered a number of relapses. Such cases are those in which healthy and diseased children are procreated alternately for a series of years, as the patient may or may not be under the influence of mercury at the time of conception.

But in cases of more severe syphilis, where the earlier symptoms are pustular instead of erythematous, where the disease is stubborn to the influence of mercury, and where there is a tendency to relapse and to ulceration, I should be inclined to prolong the treatment very considerably, not permitting the patient to marry until eighteen months or two years after the disappearance of all outward signs of disease, and the cessation of a mercurial course which had also lasted for at least eighteen months or two years, making about four years in all. This practically amounts almost to a prohibition, but if the physician is not firm in these cases, he may have cause to bitterly regret his complaisance at a subsequent date. Patients will marry, if they decide to do so, in spite of the doctor's warning; but it is a thousand times better to risk the reputation of over-cautiousness, than to have a diseased being brought into the world, which has been begotten under the sanction of the physician.

Regarding the fourth proposition, which is closely connected with that just discussed, the question here is pushed farther, and it is desired to know what injury can occur to the children of a parent who has had syphilis long before his marriage, who presents no signs of the disease afterwards, and whose offspring in consequence cannot be expected to show any of the symptoms of syphilis in its ordinary form. Can the syphilitic taint so influence such offspring as to induce rickets, scrofula, and the like? In answer to this question I should say that not only is it contrary to all our experience that one disease should give rise to another entirely distinct from it, but that in spite of the fascination which this theory of scrofula as a derivative of syphilis has exercised over the minds of able observers, it has never been possible to bring forward a sufficient number of cases in proof of the theory to convince those who had not previously made up their minds on the subject. No, as has been said in the earlier part of this article, syphilis is a distinct entity, and can beget syphilis alone. It may appear alongside of scrofula, and may run a parallel course with that affection. It may predispose by its cachectic influence to the development of the so-called scrofulous maladies, or the scrofulous taint may cause the subject to suffer the severer ravages of syphilis. But as for a combination such has been fancied, analogous to that between two chemical elements (*e. g.* the "scrofulate of syphilis," of Devergie), this has never been shown to exist.

So far from syphilis gradually tapering off into serofula, it is in reality cut short and extinguished. Many children and adults are alive and in blooming health at this day, one or even both of whose parents were the subjects at one time of syphilis.

In the case of an individual who marries with symptoms of syphilitic disease already manifest upon his person, or who contracts syphilis during married life, the considerations which present themselves are different from those which have thus far been discussed. The question here is to prevent the transmission of the disease to other members of the family, and chiefly to the husband or wife, as the case may be.

When a man has a genital chancre, he seldom knowingly exposes his wife to contagion, and of course it is necessary to avoid sexual intercourse entirely at such a time. While the physician, consulted by such a person, should positively interdict all commerce of the kind, he should, at the same time, when circumstances permit, adopt either such treatment as frequent coating of the lesion with collodion or light cauterizations with nitrate of silver, or the application of some such remedy as may suggest itself to prevent the possibility of coitus. For the married man who places himself in a position to contract syphilis, is not a person of such nice sensibility as to balk at the prospect of infecting his wife when his own selfish indulgence is in question. If we can persuade him that some injury to himself may possibly accrue, we may be able to arouse him to caution and self-denial; but I have found it unsafe to appeal to any but selfish motives in such cases.

The danger from chancre past, the next, and in practice indeed the commonest danger, is from mucous patches about the mouth and lips. The married man who has suffered with chancre should examine his mouth and fauces daily during many months, in order to detect the first appearance of these extremely common lesions. When present, they should be cauterized lightly every day with nitrate of silver, with the view of coating their surface and rendering them less virulent, and at the same time the patient must be warned against kissing any one of the family, and against permitting the use after him of such utensils as spoons, cups, etc., by other persons, without previous cleansing.

Should the wife of such a person by chance become pregnant, she should undergo a course of mercurial treatment to prevent the development of syphilis in the fœtus. The earlier and more thorough the treatment of the mother, the more likely will she be to bring forth a healthy child.¹

LEGAL MEASURES TO PREVENT THE SPREAD OF SYPHILIS.

The continuance and generally increased diffusion of syphilis have attracted the attention of the medical profession more and more to the necessity of employing some means of arresting the spread of the disease. The measures proposed have been: (1) that of Auzias Turenne,² who conceived the idea that syphilis might be inoculated in the same manner as smallpox was inoculated before the discovery of vaccination, and thus immunity gained in case of subsequent exposure. (2) The supervision and examination of prostitutes

¹ For a careful examination and treatment of this subject, reference may be made to the following works:—

Langlebert, *La Syphilis dans ses rapports avec le Mariage*. Paris, 1873.

Diday, *Le Pêril Vénérien dans les Familles*. Paris, 1881.

Fournier, *Syphilis et Mariage*. Paris, 1880. A translation of this work into English has lately appeared.

² *De la Syphilisation, ou Vaccination Syphilitique* (Arch. Gén. de Méd., 4e Sér. t. xxxvi., 1851)

with the view of arresting the spread of the disease, at least at one of its sources.

The first method of prophylaxis has proved a failure, because the disease contracted by syphilization is precisely the same as that gained in other ways, both in character and degree. The second has been tried in various localities with varying results, but with as yet no decided advantage to the community at large, except in the case of some garrison towns in England, where a decided lessening of syphilis has been the result.

The question of the regulation of prostitution must inevitably be discussed in connection with that of the prevention of syphilis, and here of necessity the moralist must be interested as well as the physician. If prostitution could but be looked at from a purely medical standpoint, and only in its relation to the production of syphilitic disease, the matter would be greatly simplified. As it cannot be so in the present state of human nature, and as the moralist and theologian consider it as much within their province as that of the physician, the problem is much complicated, and must, I think, in the end, be solved by taking into consideration both points of view. Unfortunately there has been a controversy here upon points on which no controversy as it appears to me is necessary, and both sides have dealt largely in vituperation where cold facts alone are required or can be at all convincing. Almost every contribution to the subject has been made with the view of proving a pre-supposed theory, rather than of indifferently recording facts no matter what conclusions may be drawn from them.

For this reason I consider that the time has not yet come to advocate the regulation of prostitution, at least in our American cities, where the municipal government, already notoriously inefficient, would certainly be unable to devise a satisfactory method of coping with the evil, and where a breakdown in the administration of the law would be worse than having no law at all.¹

¹ The following works and papers, chiefly of a statistical character, may be referred to as giving information especially with regard to the prevention of syphilis in European countries:—
Lecour, C. J., *De la Prostitution et des mesures de police dont elle est l'objet à Paris*, etc. (Arch. Gén. de Méd., t. ii. p. 711 et 736, 1867).

Id., *La Prostitution à Paris et à Londres de 1789 à 1870*. Paris, 1870.

Crocq et Rollet, *Prophylaxie Internationale des Maladies Vénériennes* (Ann. de Derm. et de Syph., t. i. p. 353, 1869).

Cambas, *De la Prophylaxie de la Syphilis* (El Siglo Med. Translated in *Annales de Derm. et de Syph.*, t. iii., 1871-72).

Nevins, J. B., *Protection from Venereal Diseases in America* (Sanitarian, vol. viii. p. 252).

— Hong-Kong, 1878 (contagious diseases ordinance). Return to an address of the House of Commons, Feb. 13, 1880, for copy of report of the Commissioners to inquire into the workings of the Contagious Diseases Ordinance, 1867 (ordered by the House of Commons to be printed, March 11, 1880). London, 1880.

Thomson, W., *Some Results of the Contagious Disease Acts* (Med. Press and Circ., N. S., vol. xxxii., 1879, p. 341).

Gihon, A. L., *Report of the Committee on the Prevention of Venereal Disease*, presented at the eighth annual meeting of the American Public Health Association. New Orleans, 1880.

Sturgis, F. R., *Relations of Syphilis to the Public Health*. New York, 1877.

Sims, J. Marion, *Legislation and Contagious Diseases*. Phila., 1876.

Vintras, A., *On the repressive measures adopted in Paris, compared with the uncontrolled prostitution of London and New York*. London, 1867.

Henry, M. H., *Discussion on the Prevention of Syphilis at the Int. Med. Congress at Vienna, 1873*, with remarks (Am. Jour. Syph. and Derm., vol. v., 1874, p. 17).

Swayze, G. H., *Shall the spread of Syphilitic Poison be prevented?* (Phila. Med. and Surg. Reporter, Oct. 6, 1877).

— *The Regulation of Prostitution as a Sanitary Measure* (Editorial, Med. Record, vol. xvi., 1879, p. 205).

White, J. Wm., *The Prevention of Syphilis: an address prepared at the request of the Philadelphia County Medical Society, and read before it Dec. 14, 1881* (Phila. Medical Times, Jan. 14, 1882). This last is an especially able review of the entire subject from a point of view favorable to the regulation of prostitution.

VENEREAL DISEASES:

BUBON D'EMBLÉE, VENEREAL WARTS OR VEGETATIONS, PSEUDO- VENEREAL AFFECTIONS, VENEREAL DISEASES IN THE LOWER ANIMALS.

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BUBON D'EMBLÉE.

BUBON D'EMBLÉE, "or bubo at the first onset" (*Primary Bubo*), is a name applied to an inflammation of the glands of the groin, occurring after sexual intercourse, and apparently not depending upon any lesion of the genitals—the theory of those writers who introduced the term being that the peculiar virus of the chancre or chancroid might enter the lymphatic vessels of the skin or mucous membrane, and be conveyed to the nearest group of glands, there to excite its characteristic inflammation, without producing any lesion of the tissues at its point of entrance. This manner of origin was considered possible by many of the older writers upon Venereal Diseases, among whom may be mentioned, John Hunter, Vidal (de Cassis), Gibert, and Castelnau—the latter authority reporting several cases of the so-called *bubon d'embrée*, in regard to all of which, however, there is ground for doubt, either the examination of the genitals having been incomplete, or deferred too long, or the antecedents of the patient not having been sufficiently inquired into.

Ricord¹ believes that the theory of the *bubon d'embrée* is unfounded, and Cullerier² declares that the bubo which has received this name is nothing but a simple adenitis, such as may result from over-exertion or fatigue incurred in any manner whatever.

Ch. Mauriac,³ in an exhaustive study of this subject recently published, in which he has carefully studied many cases of the so-called *bubon d'embrée* occurring under his own observation, states that not one case is complete or unassailable, and that the existence of the chancroidal and of the syphilitic *bubon d'embrée* cannot be admitted. Berkeley Hill⁴ declares that the *bubon d'embrée* is not followed by syphilitic eruptions; that the pus of this bubo is not of the nature of the pus of the virulent [chancroidal] bubo; but that it often follows coitus, and is generally seen in persons of that constitutional

¹ Ricord and Hunter on Venereal Diseases, p. 341.

² Précis Iconographique des Maladies Vénériennes, p. 304.

³ Étude sur le Bubon d'Emblée. Paris, 1880.

⁴ On Syphilis and Local Contagious Disorders, p. 356.

diathesis which predisposes to glandular inflammations from other causes. Follin, like Cullerier, suggests that the *bubon d'emblée* is independent of contagion, and is simply due to the fatigue of violent intercourse.

An examination of the literature of this subject will, I think, convince any one that the existence of the *bubon d'emblée*, in the original acceptation of the term, cannot now be acknowledged, for none of the reported cases are free from the chance of error; in no case does constitutional syphilis start from this lesion, and the results of inoculation of its pus are negative. What, therefore, is called the *bubon d'emblée* must be considered as either a simple adenitis, due to irritation; an inflammation of the glands due to pre-existence of a chancre or chancroid which has escaped observation, or which has healed before the glandular affection has become marked; or a gummatous affection of the glands occurring during the course of syphilis.

Dr. Sturgis reports a case of the latter affection which closely resembles many of the recorded examples of *bubon d'emblée*, and I have myself had a case under observation in which symmetrical buboes occurred without apparent cause, in a patient who had been for some time suffering from constitutional syphilis, and in whom the inguinal affection rapidly disappeared under constitutional treatment. Mauriac¹ reports three cases of gummatous inflammation of the inguinal glands, and Verneuil² has observed several cases of the same nature.

TREATMENT.—The treatment of the so-called *bubon d'emblée* consists, first, in putting the patient at rest, and then making counter-irritation around the inflamed area with tincture of iodine, after the manner of Mr. Jordan, applying the drug not over the affected part, but over the “next vascular area;” poultices may also be applied, and, if the inflammation goes on to suppuration, a free incision should be made as soon as the presence of pus can be detected. From the fact that these buboes frequently occur in persons of strumous or debilitated constitutions, tonics are indicated, and of these, cod-liver oil and iron are to be preferred; the use of iodide of iron, either in the form of the syrup or of the officinal pill, is often followed by the most satisfactory results.

In cases which point to a gummatous inflammation of the glands of the groin, the administration of the iodide of potassium will generally effect a rapid cure, and preclude the necessity of any operative interference.

VENEREAL WARTS OR VEGETATIONS.

VENEREAL WARTS OR VEGETATIONS are highly vascular, papillary growths, springing from the mucous membrane or the skin; they occur most frequently on the genital organs, and are identical in their nature with warts seen in other parts of the body. “They are exceedingly vascular, and are made up of connective tissue elements, which make a mass of firm consistence; the papillæ are much hypertrophied, and are covered with an extensive mucous layer; the horny layer may be found developed in warts in certain localities.”³

NATURE OF VEGETATIONS.—The term “venereal” is not, strictly speaking, correct, as these growths are sometimes seen in children, in pregnant women free from venereal taint, and in persons who have never had sexual intercourse, seeming, in these cases, to arise from the irritation produced by the

¹ Gazette des Hôpitaux, 1879.

² Hill, op. cit., p. 203.

³ Duhring, Diseases of the Skin, p. 467.



Vegetations of Vulva and Penis.

decomposition of the natural secretions of the parts; but, on the other hand, it must be acknowledged that the irritating discharges arising from venereal diseases are a frequent cause of their production. The occasional occurrence of these vegetations in the lower animals also furnishes additional evidence of their not necessarily being of venereal origin.

The special susceptibility of the mucous membranes and skin of certain persons to the production of warts, has been attributed to constitutional peculiarity or inherited predisposition, and by Martin to the presence of a "lymphatic diathesis." Diday,¹ from an investigation of fifty-five cases of warts upon the genital organs, found that, in forty-seven cases, the patients had suffered during childhood from warts occurring elsewhere.

The favorite seats for the production of these growths in the male are, the internal surface of the prepuce, the furrow behind the corona glandis, the glans penis itself, and the edge of, or just within, the meatus; in the female, they appear on the labia, the vagina, and about the anus. Heat and moisture—conditions which exist in the above-named localities—are elements favorable for the development of vegetations. The condition of phimosis acts as a predisposing cause in the production of these growths, the concealed condition of the parts rendering the removal of the natural secretions, or of the discharges due to venereal disease, difficult or impossible.

APPEARANCE OF VENEREAL WARTS.—When situated upon the genitals, warts are generally attended with a whitish or yellowish discharge, due to the irritation caused by friction, or to positive ulceration; from the heat of the parts, the discharge undergoes decomposition, and gives rise to a peculiarly offensive odor. In shape and size the growths may present great variety, this depending much on their location; on the glans penis, and on the inner surface of the prepuce (Plate XXIV. Fig. 1), they may occur as elevated masses, granular in appearance, and either sessile or pedunculated; or they may exist singly, as slightly flattened cones. When they occur on the skin of the prepuce or on the body of the penis, they are apt to be conical in shape, and to show a predominance of the horny layer; in the neighborhood of the anus they may occur as elevated masses, flattened by pressure (Fig. 345); and in the female genitalia they are frequently seen as large masses, resembling cauliflower excrecences (Plate XXIV. Fig. 2). The extent to which these growths may invade certain localities is only limited by the area of surface favorable for their production; the anus and vulva may be completely surrounded; the vagina may be almost occluded; and the configuration of the glans penis and prepuce may be entirely masked.

CAUSES OF VEGETATIONS; QUESTION OF CONTAGION.—These growths are more common in women than in men; the large extent of mucous surface liable to be irritated by the secretions

Fig. 345.



Vegetations around anus in a child.

¹ Diday, *Thérapeutique des Maladies Vénériennes*, p. 346, 1876.

disordered through venery, or by the unhealthy discharges from the parts, offering a fruitful soil for their production. The existence of pregnancy also favors the production of warts, probably on account of the engorged state of the genital mucous membrane, dependent on the pelvic congestion normally seen in this condition; under these circumstances, the growth of vegetations may be so rapid and extensive as entirely to fill up the vaginal canal. The occasional presence of these growths on mucous patches has caused some authorities to consider them as syphilitic in nature; but their coexistence seems rather accidental than otherwise, and that they are not due to syphilitic contamination is shown by the fact that they are cured by local treatment only, and are not affected by constitutional remedies.

As regards the *contagiousness* of these growths, much difference of opinion exists, some authorities considering them eminently contagious, while others believe them incapable of being transmitted in this way. In many instances they certainly seem to be communicated by direct contact, as in a case recently brought under my notice, in which four young men had each a profuse development of vegetations, after intercourse with the same woman, who was herself suffering from warts at the time. Whether, however, in such cases, the growths are caused by direct contact with the growths existing in the woman, or by exposure to the irritating vaginal discharge which itself produced the original crop, is a question which cannot be definitely settled; but, on the whole, the weight of evidence favors the former view, and it is probable that, as believed by Bumstead, the contagious property resides in the secretions from the warts themselves.

TREATMENT OF VEGETATIONS.—The removal of venereal warts may be effected in various ways, either by excision, by the use of caustics, or the cautery, by ligation, or by the application of astringent or desiccating powders. *Ligation* is a tedious method, and is now seldom employed.

Excision, one of the most popular methods, is accomplished by shaving or snipping off the growths with knife or scissors, the cut surface being then touched with some caustic or astringent; this method has the disadvantage of being followed, in some cases, by profuse hemorrhage, which, if the growths removed have been extensive, may be difficult to control.

The actual cautery may also be applied for the removal of these growths, either in the form of the hot iron, or the hot loop of the galvano-cautery, or in the form of Paquelin's cautery; it presents a method of treatment which is both efficient, and at the same time free from the risk of troublesome hemorrhage.

Caustics and Astringents.—In other cases the growths may be simply touched with nitric acid, chromic acid, or the liq. plumbi subacetatis, or, when small, may be dusted with calomel, tannic acid and lycopodium, or dried alum. The use of chromic acid has been highly recommended by Mr. Frommer,¹ Mr. Marshall,² and Dr. Crawcour,³ and is, by Prof. Ashhurst, preferred to any other mode of treatment; it is in many cases followed by the most satisfactory results. Both Dr. Keyes and Dr. Bumstead recommend a preparation consisting of corrosive sublimate, ʒj, with collodion, fʒj, to be painted on the growths; they consider this a particularly efficacious remedy in the dry form of the disease.

Treated by any of these means, warts will sometimes recur, in which case the same procedure should be repeated. Keeping the parts clean, and as dry

¹ Dublin Journal of Medical Science, vol. xiii. p. 250.

² Ranking's Half-Yearly Abstract, vol. xxv. p. 183.

³ New Orleans Medical News, Nov. 1857.

as possible, after the growths have been destroyed, is an important adjuvant in effecting a permanent cure.

The large growths which occur during pregnancy should not be subjected to operative interference; the treatment here should be palliative, consisting in keeping the parts clean by the use of a disinfectant lotion, such as Labarraque's solution, since a spontaneous cure may take place after delivery; if, however, the growths persist, they may be dealt with at the proper time, as in other cases.

The treatment of warts, when complicated with phimosis, generally requires operative interference, either by splitting the prepuce, or by a formal circumcision, so as to afford the necessary exposure of the growths; when made accessible by either of these methods, the warts can be excised, or touched with caustics or astringents in the way already described. Circumcision has the advantage of leaving the parts in a condition less favorable for the reproduction of the disease.

PSEUDO-VENEREAL AFFECTIONS.

Under this name may be included several diseases which are transmissible by contact, and, therefore, by sexual intercourse when the generative organs happen to be affected, but which have no necessary or even habitual dependence upon such intercourse, and are not, therefore, strictly entitled to be called venereal. Some of the affections to be described under this head are, however, probably really identical with syphilis.

YAWS. (Synonyms: *Frambæsia*, *Pian*.)—These names have been given to an affection which is endemic among the negroes on the west coast of Africa, and which has from that locality been transported by slave traders to the West Indies, and to the Southern States of America. This disease was described by the Arabian physicians as early as the tenth century, and from them received the name of Sahafti.¹ According to Lancereaux,² it is met with as an endemic disease from the left bank of the Senegal River to Cape Negro, in Senegambia, Congo, Sierra Leone, and Nigritia, and in the colonies which have drawn their slave supply from those regions. Milroy³ believes that the geographical distribution of the disease is much wider than is generally supposed, and that it occurs not only on the west coast of Africa, but in the islands of the Pacific, in South America, in the Melanesian Islands, and on the east coast of Africa.

Symptoms.—The symptoms of yaws, according to most authorities, are lassitude, malaise, more or less fever, pain in the joints, and a papular eruption which goes through various phases of development, and which in certain stages, from its resemblance to the wild raspberry, has caused the disease to receive the name "*frambæsia*." At a later period the patient suffers from ulcerations, osteocopic pains, and various affections of the bones—exostoses, necrosis, and caries—and in rare cases from gangrene. Imray⁴ declares that little constitutional disturbance is manifested at the outset of the disease, and that it is not until the affection has existed for some time that the general health suffers, when the patient becomes emaciated and debilitated from the attending pain and ulceration.

¹ Theodoric, lib. viii. cap. xviii.

² Lancereaux, *Treatise on Syphilis* (New Sydenham Society's Translation), vol. i. p. 31.

³ *Medical Times and Gazette*, June, 1880.

⁴ Tilbury Fox, *Diseases of the Skin in Hot Climates*, p. 467.

"The eruption," according to Duhring,¹ "consists of variously sized papules, tubercles, and tumors, which are present in all stages of development; they begin in pin-head sized points, which enlarge until they become the size of split peas, resembling in appearance currants and raspberries; as they grow they incline to become flat on their summits, and become studded with yellowish points. In time they may become as large as cherries, become softer, are apt to break down and ulcerate, discharging a thin, fetid, yellowish fluid. These lesions may be round or semi-globular, or may coalesce, forming patches of a vegetating or fungoid nature."

Mr. Hutchinson,² in describing a case of yaws which occurred under his own observation, says that the eruption consists of small red tubercles, present in various stages of development; when they first appear, they are small red pimples, afterwards shining red vesicles, and, when more fully developed, round elevations with flat tops, of a bright pink color, glassy, and semi-transparent, but possessing more the consistence of raspberries than of currants. The substance of the tubercles is solid, they do not collapse when pricked, but blood or bloody serum oozes from them when their surface is broken. Some become pustular, and others, when fully developed, ulcerate at their bases and drop off; their bases are not surrounded by an areola of redness.

Dr. Imray³ says that if yaws are observed as they first make their appearance on the surface, one or more whitish or yellowish spots will be perceived, not larger than a pin's head; these spots are seen very distinctly on the dark skin of the negro. Gradually the spots enlarge and begin to project from the surface, retaining for the most part their circular form, and having much the appearance of small globules of yellow pus. The skin remains unbroken until the yaws attain the size of small peas, when a spongy yellow surface, from which a thin fluid oozes, presents itself, and this spongy body continues to enlarge until it projects considerably from the surface. The most common seats of the eruption are on the face, neck, genitals, perineum, and anus; upon the vulva and upon the lips, the eruption may be so profuse as to form a complete ring around the orifices. The lesions show no regularity of distribution, and are neither painful nor itching. When, however, the fungous excrescences appear on the soles of the feet, where they are prevented from rising by the thick epidermis, they cause those parts to become painful and swollen, and thereby offer a great impediment to walking. In this situation they are called by the natives of the West Indies *tubbe*, or crab yaws; the case observed by Mr. Hutchinson presented this lesion. When the eruption disappears without ulceration, dark spots are left which gradually fade away, but when there has been much ulceration deep scars are produced which are permanent.

The disease is acquired by direct contact with those suffering from yaws, or by means of eating or drinking utensils, etc. From the almost constant presence of the eruption on the genitals, coitus is a frequent means of its transmission. In the West Indies, it is said also to be produced by the bite of a large fly, which, from its supposed agency in producing the disease, has received the name "yaw fly."

The period of incubation of the disease is from three to ten weeks, and its duration is from nine to thirteen months; one attack is believed to protect the patient against further invasions, although on this point as well as on that of hereditary transmission, it must be acknowledged that there is some difference of opinion among various observers.

Imray⁴ considers yaws a contagious, but not an infectious disease, and be-

¹ Treatise on Diseases of the Skin, p. 467.

² Descriptive Catalogue of the New Sydenham Society's Atlas of Portraits of Diseases of the Skin, p. 148.

³ Fox, op. cit., p. 468

⁴ Fox, op. cit.

lieves that it can only be communicated by contact of the sound with the diseased, or by the application of the discharges of those suffering from yaws to an abraded surface or wound. John Hunter¹ regarded this affection as contagious, and cited the case of a physician who was inoculated with yaws from a wound received while operating on a patient suffering from the disease. Thomson² believed yaws to be freely communicable by inoculation, and gave examples from his own practice of women being inoculated by suckling children who were suffering from it; he also inoculated children with yaws matter to ascertain if the disease could be modified by this procedure, but his results showed that the artificial production of yaws neither shortened its duration nor diminished its severity. These experiments of Thomson were confirmed by an observation of Paulet,³ who inoculated a child with the matter taken from the pustules of yaws; the operation was followed in three weeks by an attack of the disease which lasted for nine months. Bowerbank⁴ acknowledges only the contagiousness of yaws by direct contact of the secretion with a wound or abraded surface, and says that in Jamaica patients with yaws are admitted into the general hospitals without the disease being communicated to the other patients or to the attendants.

From the fact that yaws is frequently contracted during sexual intercourse, from its peculiar manifestations on the skin and mucous membranes, and from the fact that it is often followed by sequelæ much resembling those of syphilis, it is not surprising that the older writers considered it to be identical with that disease. Indeed, John Hunter⁵ stood almost alone among the surgeons of his time in maintaining that yaws was a distinct and separate affection. Nor can it be said that the more modern writers are unanimous in their opinions upon this point; Lancereaux⁶ and Berkeley Hill⁷ consider the identity of the two diseases well established, and adduce the fact that they are both amenable to mercurial treatment as furnishing additional evidence in support of their view. Milroy,⁸ Bowerbank, and Imray, on the other hand, while they acknowledge certain points of resemblance with syphilis, believe yaws to be a distinct and separate disease.

I think that the weight of authority and the evidence of recent observers certainly point to the non-identity of the two affections, a view which is sustained also by the fact that both diseases can exist in the same patient at the same time; Milroy mentions a case where yaw-ulcers and syphilis existed simultaneously, and Dr. Ross also cites a case of syphilis and yaws being found in the same patient, the syphilis getting well under mercurial treatment, while the yaws remained.

Treatment of Yaws.—Thomson says that the natives of the West Indies looked upon this disease with peculiar disgust, and that patients suffering from yaws were isolated on remote parts of the estates, receiving little care except from negro attendants, and being seldom brought to the notice of European physicians. The natives employed in the treatment of this disease the flowers of sulphur, dusted on the ulcerated parts, and the contused leaves of the physic-nut (*Jatropha curcas*), and the juice of the bitter cassava (*Manihot*).

The treatment of yaws, according to Imray, consists in the use of baths to encourage the full development of the eruption, and in the exhibition of sulphur and of the bitartrate of potassium, for the first six or eight days. Mercury is then given, with decoction of sarsaparilla or sassafras, but

¹ Works, vol. ii. p. 471.

² Lancereaux, op. cit., vol. i. p. 33.

³ Op. cit.

⁷ Op. cit., p. 15.

² Edinburgh Med. and Surg. Jour., vols. xv.—xviii.

⁴ Medical Times and Gazette, June, 1880.

⁶ Op. cit., p. 33.

⁸ Leprosy and Yaws in the West Indies, 1873.

it is stopped as soon as the gums begin to show the slightest evidence of its constitutional action. Tonics should be given to persons of enfeebled constitution in conjunction with the mercury. The patient should be allowed a generous diet, and the greatest attention should be paid to cleanliness, upon which indeed Thomson, who disapproved of the mercurial treatment, depended almost exclusively. Locally, a weak ointment of the acid nitrate of mercury, or a solution of carbolic acid, may be used with benefit; the latter remedy Dr. Murray¹ has also administered internally with good results. Bowerbank speaks well of the mercurial treatment as shortening the course of the affection, but thinks that the disease is more apt to be followed by sequelæ when it is used; he also says that the iodide of potassium is efficacious in certain cases, especially those in which the mucous membranes are involved.

PARANGI.—Mr. Kynsey² describes a disease which has existed for many years in Ceylon, and to which the name of Parangi is given. It presents a stage of *incubation* in which a sore is found on some part of the body, and which is followed by a stage of *invasion*, characterized by the development of slight fever and dull pain in the joints. The *eruptive* stage follows this, and lasts for several weeks or months, ending either in convalescence or in the development of certain sequelæ, among which may be mentioned ulcers, by which the eruption may be succeeded. The affection is contagious, through the secretions from the eruption or ulcers coming in contact with an abraded surface, or even with the healthy skin, and it is also supposed to be capable of hereditary transmission; one attack seems to confer immunity from others. Mr. Kynsey points out the similarity of this disease, in its clinical history, to syphilis; but believes it to be allied to, if not identical with, yaws. The Parangi disease of Ceylon is also described by Tilbury Fox.³

VERRUGAS.—Under the name Verrugas, Dr. Ward,⁴ of Peru, describes a disease existing in that country, which bears some resemblance to yaws; it is usually preceded by an initial fever, lasting from ten to thirty days, and is accompanied by excruciating pain of a rheumatic character, finally culminating in an eruption of warty growths upon the body; these occasionally proceed to suppuration or ulceration. By reference to Dr. Ward's article it will be seen that this affection lacks many of the symptoms and characteristic features of yaws, of which disease Dr. Duhring nevertheless considers it a variety, as he does a somewhat similar affection which occurs in the valley of the Amazon.

SIBBENS OR SIVVENS.—This is a disease peculiar to the west coast of Scotland, occurring in the districts of Galloway, Dumfriesshire, Ayr, etc. It was first described in the seventeenth century, and was supposed to have been introduced by the troops of Charles the Second; the disease is now almost if not entirely extinct.

Gilchrist⁵ describes the disease as beginning with a sore throat or inflammation of the palate, the tonsils being covered with white sloughs, or ulcerated. In other cases there are elevated patches of a red or whitish color, resembling the eruption of yaws; this resemblance is pointed out by Berkeley Hill, who does not consider sibbens entitled to be regarded as a distinct

¹ Milroy, op. cit.

² Report on the "Parangi Disease" of Ceylon, 1881.

³ Skin Diseases of India, p. 95, 1876.

⁴ Trans. of Internat. Med. Congress, Philadelphia, 1876.

⁵ Craigie, Practice of Physic, vol. i. p. 682.

affection. Wills¹ speaks of the disease as originating in the form of condylo-mata or tubercles, which may ulcerate; the latter manifestations of the disease are confined to the skin and bones. Skae² reports an epidemic of condylo-mata under his own observation, which he considered identical with sibbens; it was characterized by the appearance of whitish or yellowish elevated patches on the mucous membranes of the mouth, genitals, and anus.

The most frequent seats of the eruption of sibbens seem to have been the tongue, palate, lips, cheeks, and genital organs. The disease was contagious, and was communicated by coitus, or by using the same eating and drinking utensils. Some authorities have considered this disease to be identical with syphilis; among these may be mentioned Adams,³ Berkeley Hill, Lancereaux, and Hill⁴ of Dumfries. On the other hand, Skae and Gilchrist believed it to be a distinct affection.

The *treatment* of sibbens consisted in the exhibition of mercury, and in the application of astringents to the condylo-mata and ulcers.

RADESYPGE OR RADZYPGE is a disease occurring on the sea-coast districts of Norway, Sweden, Iceland, and Greenland, and first noticed about the year 1710.

"It is a disease beginning with fever and catarrhal symptoms, more or less violent, and terminating in the eruption of papules and tubercles on the skin, and patches on the mucous membrane of the nose and throat; these may go on to ulceration; the patient may suffer from wandering pains in the joints resembling rheumatism, which are aggravated at night."⁵

Charlton⁶ describes radesypge as a disease chiefly characterized by ulcerations of the nose, mouth, and fauces, which considerably resemble the ulcerations of syphilis. The palate and nasal bones are in some cases destroyed.

The patients complain of burning pain, and perspire freely; hectic and colliquative diarrhoea set in, and frequently cause a fatal termination of the case.

The disease is said to be contagious through the perspiration, saliva, and discharges from the sores. The cold, damp, and inclement weather of the districts where it prevails, the poor quality of the food, consisting principally of oily fishes, and the imperfect ventilation of the dwellings, are important elements in its production and spread. Hubener,⁷ Hünfeld, Struve, Craigie, and Lancereaux believe that this disease is identical with syphilis, and mention the affections of the mucous membrane, mouth, skin, and bones in confirmation of their opinion; Charlton, on the other hand, considers it a distinct affection. Some authorities are disposed to consider it a form of leprosy.

Treatment.—Struve⁸ speaks highly of the employment of corrosive sublimate combined with sarsaparilla or sassafra, and believes that cleanliness, good food, and the use of flannel clothing, are important elements in the cure of the disease; as a local application to the ulcers, he recommends corrosive sublimate and lime-water, or yellow wash.

SCHERLIEVO OR FIUME.—This was an endemic disease which existed on the coasts of Illyria, Dalmatia, and Croatia, during the last century. The disease

¹ Edinburgh Med. Journ., 1844, page 282.

² Observations on Morbid Poisons, London, 1807.

³ Cases in Surgery, Edinburgh, 1772.

⁴ Craigie, Practice of Physic, vol. i. p. 690.

⁵ Edinburgh Med. Journ., vol. xlviii. p. 101.

⁶ Ibid.

⁷ Skae, *Ibid.* p. 615.

⁸ Craigie, *op. cit.*, p. 696.

attacked the face and skin generally, in the form of malignant pustules, which were followed by ulceration and by caries of the bones.¹ It was described by MM. Percy and Laurent² as commencing with lassitude and pains in the bones, which increased at night; the voice became hoarse, deglutition was difficult, the uvula, tongue and pharynx became red and aphthous; ulcers formed, and were followed by caries of the bones, and by the discharge of fetid pus. The disease was said to have been imported by four sailors, who came from the banks of the Danube after the war against the Turks. The disease was probably identical with syphilis.

FALCADINA.—A disease which appeared in the year 1786, in the village of Falcado, contiguous to the Tyrol; its occurrence was attributed to importation through a female mendicant with ulceration of the pudendal mucous membrane. After general uneasiness, lassitude, sickness, osteocopic pains, and fever, a pustular swelling of the lips and mouth appeared, which proceeded to ulceration, affecting the velum palati, uvula, tonsils, and nasal mucous membrane; an eruption of a livid red color also appeared upon the skin. This disease was probably identical with *schierlievo* and syphilis.³

AMBOYNA PIMPLE.—A disease occurring in Amboyna and the Molucca Islands, described by Bonetus in 1718, characterized by ulceration of the soft parts, and by exostoses and caries of the bones, and transmitted independently of sexual intercourse.⁴ Lancereaux⁵ considers it identical with syphilis.

DISEASE OF ST. EUPHEMIA.—Under this name is described by Lancereaux⁶ a disease which was observed in 1727 in St. Euphemia. A midwife had a pustule on her hand, followed by a general eruption of herpes; in the practice of her profession she communicated the disease to many women, whose bodies became covered with pustules, ulcers, and hard tubercles. The disease is considered by Lancereaux to have been a variety of syphilis.

PIAN OF NERAC.—This disease showed itself in Nerac in 1752, and is supposed to have originated from suckling a syphilitic child; the disease was first communicated to the nurse, and then to other children which used the same breast; it very much resembled the preceding disease.⁷

DISEASE OF ST. PAUL'S BAY.—Swediaur⁸ described under this name a disease which appeared in Canada in the year 1760, among the fishing population of St. Paul's Bay. The disease first manifested itself in pustules on the lips, mouth, and tongue; these pustules were filled with a whitish fluid which was very contagious. At a later period the patients suffered from large ulcers, glandular swellings in the groin and throat, and violent nocturnal pains in the osseous tissues, with caries of the nasal, palate, and cranial bones, and sometimes loss of sight and hearing.

Dr. Stratton, who observed the disease among the North American Indians, found that it was most common among children and females, and that when it first appeared it was quite fatal. He did not consider it identical with syphilis, in this respect differing from Swediaur, Lancereaux, and Berkeley Hill.

¹ Lancereaux, *op. cit.*, p. 41.

² Craigie, *op. cit.*, p. 725.

³ Lancereaux, *op. cit.*, p. 38.

⁴ *Ibid.*

⁵ Copland, *Dict. of Pract. Med.*, vol. iv. p. 1336.

⁶ Copland, *op. cit.*, p. 1339.

⁷ *Ibid.*

⁸ *Treatise on Syphilis*, p. 451.

The treatment employed consisted in the use of sarsaparilla and a decoction of the hemlock spruce.

DISEASE OF CHAVANNE LURE.—This is described by Lancereaux as a disease beginning with weakness, and followed by nocturnal pains in the joints of greater or less severity; the mouth and throat were affected, and a pustular eruption appeared on the whole surface of the body, especially marked on the head. The use in common of eating and drinking utensils was the chief means of propagation.

Lancereaux regards this affection, as he does all the others which have been mentioned, as actually identical with syphilis.

VENEREAL DISEASES IN THE LOWER ANIMALS.

The question of the susceptibility of the lower animals to venereal diseases has for a long time claimed the attention of syphilographers, and numerous experiments have been made, by inoculating animals with the discharges arising from venereal sores in man, to prove or disprove their susceptibility to this class of diseases.

Hunter,¹ Ricord, Cullerier, and others experimented upon the lower animals by inoculating the discharge from the true chancre, with negative results as far as the production of constitutional syphilis was concerned, although a sore resembling the chancreoid could be produced. On the other hand, De Wultz,² Auzias Turenne, and others, are said to have produced, by inoculation, sores which resembled the true chancre. M. Langlebert³ states that he saw on the arm of M. de Wultz a well-marked chancre which had been inoculated by M. Ricord himself, who took the pus from a chancre on a monkey; but as at this time the distinction between the chancre and chancreoid was not clearly drawn, and as no mention is made of the development of constitutional symptoms, little weight can be attached to this observation.

Recent investigations tend to confirm the observations of Hunter and Ricord, that the chancreoid can be reproduced in the lower animals, while the inoculation of the discharge from the true chancre is only followed by an ulcer, local in its character, and unattended with symptoms of constitutional syphilis.

Jullien,⁴ in speaking of the experiments of Auzias Turenne, says that they relate to the contagion of the chancreoid, and that the symptoms following his inoculations were only visible to himself; and that, on the other hand, there have been too many negative results recorded by Ricord, Diday, Langlebert, Horand, and Puech—which contradict Auzias Turenne's observations—to allow us to give them the slightest credence. In regard to inoculations upon dogs, Jullien adduces the experiments of Velpeau, Bretonneau, Horand, and Puech, and the conclusions of Bouley, as showing that the lesions produced upon these animals are not different from the ulcerations so frequently noticed on the ears of certain hunting dogs.

The same observer, in speaking of a disease which exists among horses, and which is called the disease of coitus, and will be presently referred to again under the name of "La Dourine," says that though this malady, which is possibly venereal, and of which the contagious character seems

¹ Vidal, *Treatise on Venereal Disease* (transl. by Blackman), p. 36.

² *Ibid.*, p. 37.

³ *Ibid.*, p. 37.

⁴ *Traité Pratique des Maladies Vénériennes*, p. 547.

scarcely disputable, has some singular affinities with syphilis, yet nevertheless, scientifically, we are not in a position to say that it is syphilis. This disease was observed by Ammon in 1796, in the North of Persia, and has since spread to Europe and Africa; it is characterized by ulcers on the genitals, followed by eruptions on the skin, various nervous symptoms, paralysis, and slow death. Ballardini described the affection in 1849 as syphilis of horses.

Carenzi, of Turin, in 1874, made experiments to determine the susceptibility of animals of the bovine species to the inoculation of syphilis, but unfortunately the case on which he based his most positive conclusions has been interpreted in a diametrically opposite sense by Prof. Gamberini, of Bologna. The experiment was made upon a heifer which was inoculated with the pus from a patient suffering from multiple venereal ulcers; at certain intervals after the inoculation there appeared eruptions, induration of the mammary glands, loss of hair, and constitutional disturbance; at the end of 229 days all the symptoms had disappeared, and the general health of the animal was re-established. On the 131st day, Dr. Giacomini inoculated a young girl with the detritus of the heifer's first set of papules, and this operation was at the end of a week followed by the appearance of small distinct papules of a copper color, identical with those on the animal. According to Gamberini, the patient who furnished the pus for the first inoculation was suffering from chancre, and the heifer did not present the symptoms of constitutional syphilis, the loss of hair being a common occurrence among ruminants during the month of March; the patient also who was inoculated from the heifer was only under observation for eight days, a circumstance which renders the observation valueless as regards the symptoms which she presented.

Jullien also gives the results of inoculation in several other species of animals, all being negative as regards the production of syphilis; and concludes with the observation "that up to the present time syphilis remains entirely peculiar to the human race."

The conclusion of Belhomme and Martin¹ is to the same effect: that the syphilitic virus is not transmitted to animals, and that its inoculation is always followed by negative results; and that, on the other hand, the pus of the simple chancre (chancre) can be transmitted to animals, giving rise to an ulcer the discharge from which, when reinoculated on man, gives rise to a simple chancre or chancre.

The more recent investigations of Dr. Rabatel,² of Lyons, in which animals were inoculated with gonorrhœal pus, with chancreoid pus, and with the material of the chancre, the operation being in each case followed by a negative result, confirm the observations of previous investigators as regards the immunity of the lower animals from syphilis, but differ materially as to the results obtained by the inoculation of the matter of gonorrhœa and chancreoid. The experiments of most value performed by this investigator were those made by introducing sections of recently removed chancres under the skin of a bitch, and by the injection of defibrinated blood of a man suffering from well-marked secondary syphilis, into the jugular vein of a dog. Neither of these animals exhibited any symptoms of constitutional syphilis, and additional evidence of their immunity from this disease is presented in the fact that, as a result of their intercourse, the former gave birth to a litter of twelve healthy pups.

¹ *Traité de la Syphilis et des Maladies Vénériennes*, p. 85.

² *Lyons Médical*, Juin 8, 1882.

Although, however, the lower animals seem proof against the inoculation of syphilis, they present some forms of venereal disease peculiar to themselves.

Williams¹ mentions urethritis as an affection seen in stallions and bulls, as a result of frequent coitus, but does not say whether the pus resulting from this affection is capable or not of reproducing itself under favorable conditions.

Horand and Puech,² who made observations concerning urethritis in dogs, found that the affection was rare, was characterized by a scanty secretion which issued from the anterior part of the canal, was accompanied by an intense balanitis, and was of short duration. They found that inoculation of the blennorrhagic discharges from man gave rise to urethritis in dogs and to vaginitis in bitches, but that the disease did not present the same series of symptoms that it does in man. They also observed that the balanitis of dogs was much intensified by the inoculation of the blennorrhagic muco-pus of man.

Hutrel D'Arboval³ describes a disease occurring in the horse which simulates syphilis, and is characterized by an inflammation of the glans penis extending to the sheath, causing the organ to present a tense, shining appearance, and giving rise to phimosis and paraphimosis.

Under the name "La Dourine," Saint Cyr⁴ describes a disease communicable by coitus, which has prevailed among the horses of the French army. The disease was first noticed in Tarbes, in 1854, and its reappearance in 1861 was due to the importation of an infected Arabian stallion; it has existed for a long time in Syria, and is probably the same disease which was described by Ammon (see page 492). The disease first attacks the reproductive organs, where it presents certain local manifestations; these are followed by numerous eruptions, and by constitutional symptoms, the most prominent of which is a paralysis of the animal's hind quarters, sometimes becoming general. The duration of the affection is from a few months to a year; the termination is generally fatal, the animal dying of exhaustion or hypostatic pneumonia, although recovery may sometimes occur.

¹ Practice of Veterinary Surgery, p. 630.

² Jullien, loc. cit., p. 26.

³ Williams, op. cit.

⁴ Annales de Dermatologie et de Syphiligraphie, 1876-77, p. 241.

INJURIES OF BLOODVESSELS.

BY

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BLOODVESSELS are the musculo-elastic tubes and hollow muscles which receive, contain, and convey the blood in animals, and in man. They are naturally divided into three distinct groups or systems, whereof each is characterized by certain well-known features, namely, the *arterial*, the *venous*, and the *capillary*; together with a central organ, the heart. In this article, then, we shall have to consider, severally, the traumatic lesions of the *arteries*, the *veins*, the *capillaries*, and the *heart*, which may chance to require the attention of surgeons. But injuries of these vessels are of no especial moment to surgeons unless they cause, or are liable to cause, (1), *hemorrhage*; or (2), *destructive inflammation* of the injured vessel itself; or, (3), *gangrene* of the parts supplied or nourished by the injured vessel. We shall, therefore, have to discuss not only the several kinds or modes of injury to which the bloodvessels themselves are exposed, but, likewise, the hemorrhages, the vascular inflammations, and the gangrenes which experience has shown to result from these injuries.

SURGICAL HEMORRHAGE.

Any effusion of blood from the vessels framed to hold it, whether attended with rupture (wound), or occurring without rupture (wound) of their walls, is, in the broad or unrestricted sense of the term, a hemorrhage. Now, such effusions of blood may, in respect to origin, be *spontaneous*, or they may be *traumatic*. The first belong, for the most part, to the domain of medicine; the latter, exclusively to the domain of surgery. But not all the extravasations of blood which are caused by injuries, and, therefore, are properly called traumatic, should be denominated examples of surgical hemorrhage. For instance, it is hardly worth while to dignify a simple ecchymosis of the skin, or a common "black-eye," by styling it surgical hemorrhage, although the discoloration is wholly dependent on the extravasation of blood from vessels ruptured by violence. So, too, with most, perhaps with all traumatic hemorrhages, that are essentially trivial and require no treatment. It seems clear, then, that the term surgical hemorrhage should be applied to those instances of the traumatic extravasation of blood, only, which are, *per se*, of such importance as to require surgical treatment, or which prove fatal in default of such treatment. But, there also are certain hemorrhages, which are not traumatic, that demand the employment of surgical measures for their arrest,

as well as the cases just mentioned. For instance, bleedings from the nose which necessitate the operation of plugging the nostrils; bleeding from ulcerations of the tonsils which penetrate the internal carotid artery, and make necessary the ligation of that vessel or its parent trunk; bleedings from abscesses which lay open the arterial canals of any part; bleedings from aneurisms about to burst, which can be controlled, if at all, only by surgical procedures, etc. Moreover, there are good reasons why these, too, should be called surgical hemorrhages; for they are, in fact, examples of surgical affections attended by bleedings that require surgical treatment. The term surgical hemorrhage, then, properly belongs to all bleedings that result from injuries, from surgical operations, and from surgical diseases, which need surgical treatment; and the expression should be strictly used to convey these ideas. When employed for this purpose, the phrase surgical hemorrhage is oftentimes very convenient and useful.

IMPORTANCE OF THE SUBJECT.—Notwithstanding the importance of “shock,” hemorrhage is the most serious of all the complications attending wounds in general. More lives are lost from it, either directly or indirectly, than from all the other consequences combined, that flow from such injuries. Of the slain in battle during our War of the Rebellion, I can testify from personal observation that a very large share, about one-half I think, but possibly even more than that, perished by hemorrhage from wounds of the large blood-vessels of the neck, chest, abdomen, groin, etc., or from wounds involving vital organs like the brain and lungs, the bleeding whereof caused deadly compression of these organs, before succor could be afforded.

In a great many wounds, the first thing needed is to stop the bleeding. In wounds generally, the symptom which most alarms the bystanders, the patient himself, and too often the surgeon also, is hemorrhage, and frequently it demands immediate attention. But to operate successfully for this complication, the surgeon must divest himself of all fear, “and learn to look boldly on the open mouths of arteries.” This terse saying of Robert Liston should be graven on the memory of every one who aspires to become a surgeon. Now, it is highly befitting to know, and also to tell, how the student of surgery may divest himself of all fear in the presence of hemorrhages that are great, and by what means he may learn to look boldly on the open mouths of arteries that are large. Such spectacles naturally appal, and stupefy, and paralyze men, unless their minds have been so strengthened and prepared by special training and forethought that they can view them intelligently, and to some extent, also, consider them as experiments on the living human animal, accidentally performed, which nevertheless should be calmly and accurately noted, for the advancement of our knowledge. By special training and fore-thinking, then, the surgeon may acquire self-reliance to witness any hemorrhage without dismay, and to look on the open mouths of any arteries with complete self-possession. But to reach this end, his training must be continued until he gets an accurate and ready knowledge of the surgical anatomy of the bloodvessels; a complete knowledge of the symptoms and prognostics of hemorrhage itself; a thorough understanding of Nature's own hæmostatics; and, finally, a perfect acquaintance with the hæmostatics devised by surgical art. Amussat indeed thought that, in order to know how to arrest a hemorrhage, it was necessary to have tied the arteries in animal vivisections. The surgeon's fore-thinking should largely consist in scrutinizing the reported cases of hemorrhage in all regions of the body, in ascertaining the causes of success or failure, and in considering them with a view to devise, if possible, better plans of treatment; for reported cases of hemorrhage are, in reality, accounts of accidents which are liable to occur again.

He must continue to ponder in this way on the recorded examples of hemorrhage, until he thoroughly familiarizes himself beforehand with exactly what should be done in every class of cases and in every region of the body, together with all the exceptional occurrences. The late and highly-esteemed Dr. Otis justly observed: "It is hardly possible to unduly multiply illustrations of the management of wounded bloodvessels;"¹ and, no doubt, had the above-mentioned use of such illustrations in view when he penned the words. In brief, then, it is by thorough special training, and by patiently fortifying himself from the experience of past generations, that the surgeon acquires the boldness and positiveness, the promptness and dexterity, which are demanded in the treatment of wounded bloodvessels. But, if he have done otherwise, the anxiety and embarrassment which he manifests in the presence of hemorrhage will show how insufficient on this point his surgical knowledge and ability really are. Thus, it appears that the injuries of bloodvessels and their consequences are subjects of very great importance to both patients and surgeons, and that it is scarcely possible to make any discussion of them too thorough or elaborate.

NOMENCLATURE OF HEMORRHAGE.—Surgical hemorrhages are called *external* or *internal*, according to the situation or direction of the flow of blood in respect to the body at large, whether it be without or within the same; but they are mostly external. Internal extravasations of blood, however, are, upon the whole, more dangerous than those which are external.

Surgical hemorrhages are said to be *pelvic*, *abdominal*, *thoracic*, *axillary*, *cervical*, *brachial*, *femoral*, etc., according to the region of the body in which they occur.

Surgical hemorrhages are also described under the names of *urethral*, *renal*, *epiploic*, *gastric*, *hepatic*, *pulmonary*, etc., according to the organ that is wounded and bleeding.

Surgical hemorrhages finally are denominated, (1) *arterial*, (2) *venous*, and (3) *capillary*, according to the system of vessels from which the bleeding proceeds; and each of these varieties has much practical importance.

(1) *Arterial Hemorrhage.*—In arterial hemorrhage, the blood usually has a bright-red or scarlet color, and flows in a jerking stream, or *per saltum*; and the jets are synchronous with pulsations of the arteries themselves. Between the jets, however, the flow does not entirely cease; the stream is in reality a continuous one, whose volume is swollen by each arterial pulsation. This fact I have often noted in the arteries of the scalp, face, and extremities, when they were cut in wounds of these parts having such extent and form as to expose the open mouths to view; in wounds caused by accidents, and by surgical operations. The blood issues in jets, for the most part, from the proximal orifice only. The blood which escapes from the distal orifice is generally dark-colored, and flows in an even stream, like that which flows from wounded veins. But in some parts of the body, where the terminal branches of the arteries inosculate with exceptional freedom, the blood may issue in jets from the distal as well as from the proximal end of a divided artery; this occurrence I have often witnessed in wounds of the scalp and face, especially in those seated near the median line; I have also met with it in wounds involving the plantar and palmar arches, respectively, and in wounds of the forearm. When the blood escapes from the distal orifice in jets, it likewise retains the bright-red or arterial hue. When from any cause a vigorous hemorrhage continues, the jets soon become less strongly marked,

¹ Medical and Surgical History of the War of the Rebellion, Second Surgical Volume, p. 324.

because the volume of blood in circulation is rapidly diminishing, and at the same time the heart's action is growing weaker. The height and force of the jets are also greatly modified by the size, shape, and directness or indirectness of the aperture in the integuments and other parts external to the injured vessel. Thus, other things being equal, the jets are more strongly marked when the artery has been opened directly, and with free incision—by a sabre-cut, for instance—than when it has been indirectly pierced by a stab with a narrow-bladed knife. Again, the jets vary in accordance with the magnitude of the injured vessel itself, and the extent to which it has been laid open. So obviously true is this part of the description, that no illustrative example is needed.

(2) *Venous Hemorrhage*.—In venous hemorrhage, the blood has a dark-red or maroon color, and usually is found flowing in a dull, steady stream. But in veins which lie close to large arteries, the pulsatory movements of these vessels may be communicated to the contents of the veins, and thus when these veins are wounded, a throbbing motion may be discernible in the stream, which, however, can, with a little care, be readily distinguished from the “per saltum” of arterial hemorrhage. Again, in certain forms of cardiac disease, where the tricuspid valve does not completely close, the regurgitation consequent thereon may be attended by a peculiar pulsation in the jugular and other veins near the chest, synchronous with pulsation in the arteries; but this condition is easily recognized when attention is called to it. Furthermore, in gunshot fractures of the skull with lacerations of the dura mater, where the shot and trephine holes, and removal of the detached fragments of bone, had opened the cranial cavity extensively, I have several times seen the respiratory movements produce a notable rise and fall of blood in the cerebral veins and sinuses, synchronously with the respiratory movements themselves, the blood rising with the expiratory and falling with the inspiratory movement; and blood when settled into the bottom of these wounds, from venous and capillary oozings, was also observed to trickle away in correspondingly intermittent streams. But the suction-power which the chest exerts, through the movements of respiration, upon the great veins that enter it, acts much more strongly still on the contents of the contiguous veins, for example, the veins of the cervical, clavicular, and axillary regions; and hence venous hemorrhage in these regions may be attended with strong wave-like motions in the stream that correspond to the breathing. Hence, in these regions also, venous hemorrhages may be attended by the entrance of air into the wounded veins, it being, as it were, sucked into the open mouths of these veins by the inspiratory movements.

Venous hemorrhages, in general, are easily recognized, and give but little trouble. Occasionally, however, they spring from great vessels—for instance, the internal jugular, the axillary, the subclavian, the innominate, the azygos, the cavæ, the iliaes, and the common femoral vein—and then they may quickly destroy life. Examples of this will be adduced in the section on Wounds of Veins.

Varicose veins of the leg, thigh, rectum, etc., bleed when they burst, with a double force; for, being unprotected by valves, they possess a reflux or regurgitated current of blood, as well as a direct one, towards the aperture.

Hemorrhages from the almost valveless veins of the head and neck may be greatly increased by the struggles and cries of patients, especially when restraint is employed and the posture is recumbent.

Superficial lacerations of the liver bleed inordinately, because the hepatic veins, being not contractile and not surrounded with loose tissue, cannot close nor even collapse when divided, and their mouths are held open by the surrounding structures.

But in most cases where venous hemorrhage proves troublesome, it is because there is some undue pressure acting upon the veins above the seat of the hemorrhage, that is, between it and the heart. The loosening of the tourniquet stops bleeding from the veins of a stump. At the battle of Ball's Bluff, I saw a soldier having a shot flesh-wound of the left arm, who was much weakened and exsanguinated from a venous hemorrhage that was caused by applying an improvised tourniquet above the wound (it was done by a comrade), and was readily stopped on removing the cause. The late Drs. Neill and McClellan, of Philadelphia, were called one night to see a young man who had lost a "deluge" of blood in bed from return of the bleeding six hours after venesection, and found that the difficulty had proceeded from the tightly retracted sleeve of a woven undershirt, which had not been drawn down into place along with the shirt-sleeve after the venesection was over. On another occasion, McClellan "was called back to suppress a frightful venous hemorrhage," in a case where he had removed a very large tumor involving one of the breasts of an unmarried woman; and, on opening the dressings, found that the long strips of adhesive plaster, put on to maintain the apposition of the edges, had tightly compressed several large varicose cutaneous veins, above and in front of the wound, *i. e.*, on the cardiac side of it; "the moment the strips were removed, the hemorrhage ceased."¹

Muscular contractions, whether voluntary or otherwise, favor the occurrence of venous hemorrhage in the limbs, because of the compression they exert on the wounded veins.

Venous hemorrhage may also be increased by placing the wounded part in a depending position, whereby the blood gravitates towards the hole in the vein. I have often noticed this fact in amputating the thigh. On lifting up the stump, the hemorrhage from the femoral vein generally ceases. On depressing it again the bleeding may return.

Often, when venous hemorrhage occurs in one of the great cavities, it may prove fatal not only by reason of the quantity of blood that is effused, but also because of its confinement in the cavity; for instance, when a ruptured sinus of the dura mater bleeds, death from compression of the brain not unfrequently follows.

(3) *Capillary Hemorrhage.*—In capillary hemorrhage, the blood discharged is not as bright-red as the arterial, nor yet is it as dark-red as the venous blood; and thus it has a peculiar color of its own. Moreover, it does not issue in distinguishable streams from the affected vessels or parts, but apparently oozes out of the bleeding surface. Capillary bleedings are generally small or moderate in extent; sometimes, however, they are so profuse as to endanger and even destroy life.

Capillary hemorrhages are often met with on the free surface of mucous membranes; for instance, on that which lines the nasal fossæ, the gums, the urethra, etc.

The capillaries when wounded, as a rule, do not bleed much, as already indicated. A single gush, or at most a few gushes occur from their open mouths, which are at once shut up by contraction of the muscular fibres in their walls, and then the bleeding is at an end.

Sometimes, however, the capillaries when wounded do not contract immediately, nor even speedily, and then they may discharge a great deal of blood before the flow can be arrested. I have seen this happen in amputations and other cutting operations performed in parts that were inflamed; and examples

¹ Principles and Practice of Surgery. By George McClellan, M.D., pp. 194–198.

of it will be presented in the section on Parenchymatous Hemorrhage. In operations performed by the bloodless method of Esmarch, tardiness of contraction on the part of the wounded capillaries may subsequently be attended with the loss of much blood.

Capillary hemorrhages in granulating wounds may be produced by excesses in drinking, and by indulgence in venery; I have seen examples of both accidents.

Capillary hemorrhages in granulating wounds too, are often caused by the formation of thrombi in the veins which should carry the blood away from these wounds; cases illustrating this point will also be adduced in the section on Parenchymatous Hemorrhage.

The chief factors concerned in producing the bleeding from capillaries which require surgical treatment, are: 1. Excessive blood-pressure in the arteries, whereby the capillaries themselves are burst open and the blood is forced out through minute rents in their walls: *e.g.*, the nasal hemorrhages often met with in Bright's disease, the hemorrhages from granulating surfaces which result from indulgence in venery and from excessive drinking, etc.; 2. Inability on the part of the capillaries themselves, when severed, to contract, and thus close their open mouths, in consequence of paralysis, more or less complete, of their walls; and 3. Obstruction to the onward flow of blood, which is not unfrequently caused by occlusion (plugging) with coagula or thrombi of the veins that should conduct the blood away from wounds and granulating surfaces: *e.g.*, parenchymatous hemorrhage occurring in pyæmia and other debilitating diseases which produce thrombosis.

But all the traumatic hemorrhages, those that are internal as well as those that are external, and those proceeding from wounded veins and capillaries as well as those proceeding from wounded arteries, are naturally separable into four distinct groups or classes, each of which, in practice, has great importance, viz.: (1). *Primary*; (2). *Intermediary*; (3). *Secondary*; and (4). *Parenchymatous* hemorrhage. Now, this classification of the traumatic hemorrhages, while quite unarbitrary, is still very useful for purposes of study and description; and this circumstance should commend it to general favor and acceptance.

(1) By *primary hemorrhage* is meant the effusion of blood which usually attends immediately upon the wounding of bloodvessels, that is, the hemorrhage which takes place at the moment the wound is inflicted. Its phenomena vary considerably according to whether it proceeds from veins, from arteries, or from capillaries; and when it proceeds from a wounded artery, the phenomena vary with the extent of the aperture in its walls, that is, according to whether the vessel is completely or only partially divided; they also vary with the nature of the wound of the artery itself, that is, according to whether it has been inflicted by a sharp, cutting instrument which would make an *incised* wound; or by a sharp-pointed instrument, like a narrow dagger, or a bayonet, which would cause a *punctured* wound; or whether the vessel has been torn across by stretching, so as to sustain a *lacerated* wound, such as sometimes results from a limb being caught in machinery; or whether the coats of the vessel have been bruised, thereby sustaining a *contused* wound; or, finally, whether the artery has been opened by a gunshot missile, which usually makes a wound both contused and lacerated, a *gunshot* wound. Primary hemorrhage is, therefore, a subject which must be considered in connection with the several kinds of injury, or wounds, to which the bloodvessels are exposed; and, in our description of these wounds, severally, a full discussion of this subject will be presented.

(2) By *intermediary hemorrhage* is meant an effusion of blood from wounded

vessels which presents itself during what is called the intermediary period in the natural history of wounds, that is, during the period that intervenes between the stage of depression from shock on the one hand, and the stage which is marked by the occurrence of suppuration on the other. Intermediary hemorrhages, therefore, come on with reaction from shock, before the apertures in wounded bloodvessels are securely closed, as well as before the appearance of purulent matter; either because the blood pressure is unduly increased by reaction, or because the external compression has ceased to be properly applied, the occluding coagula becoming thus displaced, and the blood flowing out afresh.

(3) By *secondary hemorrhage* is meant an effusion of blood from wounded vessels which does not occur until the establishment of suppuration, and the consequent separation of sloughs, eschars, etc., from the injured vessels. It does not appear before the fifth or sixth day after the infliction of a wound, and is most liable to happen about the twelfth or fourteenth day.

(4) By *parenchymatous hemorrhage* is meant a sanguineous effusion in which the blood does not issue from the wounded, granulating, or ulcerating surface, in distinct streams, but seems to be poured out therefrom by a process of general oozing through small apertures, that is, from the parenchyma or substance of the part.

Each of the three last varieties of traumatic hemorrhage will be thoroughly discussed by itself in a distinct section, after the wounds of arteries have been described.

CONSTITUTIONAL SIGNS OF HEMORRHAGE.—By loss of blood or hemorrhage a strikingly changed appearance of the human body, sometimes called exsanguinated or bloodless, is produced. The countenance, ears, lips, buccal mucous membrane, conjunctivæ, and general integuments, become deathly pallid, and pinched or shrunken from departure of blood; the expression becomes languid or vacant, and the surface is wet with cold sweat, which may stand in drops. At the same time, the functions of the brain, from anæmia of its substance, are greatly disturbed: humming, roaring, or ringing sounds are heard in the ears; a thick mist, or even darkness, perhaps illuminated with flashes of strange light, comes before the eyes; the sense of feeling is benumbed; and unconsciousness, with syncope or convulsions, follows. There is also extreme debility, with a faint voice, feeble, sighing, or gasping respiration, and small, frequent, weak, fluttering, or even scarcely perceptible pulse. Such are the general symptoms which attend and characterize excessive loss of blood, whether it be poured out externally or into the great cavities of the trunk. There are, however, some considerable differences between the symptoms that appear in the slow and in the sudden hemorrhages. In the former, the patient is very slowly exhausted; at each return of bleeding he faints, and is laid in bed, and applications of cold, and the fainting itself, save his life. After some days, he rises, pale, languid, and giddy; his pulse flutters, and is hardly to be felt; his breathing is quick and anxious, accompanied with sighing and great oppression; his heart palpitates on the slightest exertion; and the slightest inclination of his head, or rising suddenly from the couch, endangers fainting. His voice is low; his eye is languid, colorless, and of a pearly white; his flesh feels soft and woolly, and his skin is pale and yellowish, gelatinous, and, as it were, translucent, like modelled wax. After this stage of weakness, the blood loses its color; from this time forward it is a bloody serum only that distils from the vessels; dropsy appears; and the slightest loss of blood proves fatal. (John Bell.)

But, when the patient dies suddenly by an impetuous hemorrhage from

some great artery; when he succumbs to the bleeding from a femoral aneurism; when he is wounded in the chest or abdomen, and some large vessel is pouring out a great stream, the blood circulating at large, in place of being forced onward by the contractions of the arteries, runs backward toward the hole in the wounded artery from all parts of the body. The arteries no longer push forward the contents of the veins; the blood ceases to flow toward the heart; the heart itself ceases to act; and the countenance assumes, as in asphyxia, a livid tinge from the stagnation of venous blood. The face becomes, all at once, deadly pale, the circle round the eyes is livid, the lips are black, and the extremities are cold. The patient faints, revives, and faints again, with a low and quivering pulse; he has nausea, and his voice disappears. There is an anxious and incessant tossing of the arms, with restlessness, which is the most fatal sign of all. He tosses continually from side to side; his head falls down in the bed; at times he suddenly raises his head, gasping for breath, with inexpressible anxiety; the tossing of the limbs continues; he draws long, convulsive sighs; the pulse flutters and intermits with the breathing, more and more, and he expires. The countenance has not the translucent pallor which is mentioned above, but the clayey and leaden hue which painters represent in those who are assassinated or killed in battle. (John Bell.) I can further unite with this graphic writer in stating, from my own personal observation, that the incessant tossing of the limbs, which is commonly represented as the sign of a fatal wound, is, indeed, so infallible a sign of death that I have never known any one to recover from hemorrhage who exhibited this condition of indescribable restlessness.

But some of the symptoms require additional mention. During syncope from hemorrhage, the act of breathing is very feeble, and performed by the diaphragm alone. After syncope, an attack of vomiting often attends the return of consciousness. At the same time, as the heart resumes its functions, contracting feebly at first, but afterwards with frequency and occasionally even with violence, the pulse becomes quick, jerking, soft, and easily compressible, the tube of the artery itself being large, not tense, and contracting very imperfectly after each small wave of blood has shot through it, thus constituting the so-called *hemorrhagic pulse*. If, instead of bounding and jerking and thrilling, the pulse is feeble and soft, perhaps barely perceptible, after reaction from syncope, it is almost certain that further loss of blood can be prevented by moderate measures.

Hemorrhagic Fever.—After great losses of blood, a condition of body characterized by a tendency to febrile movement, with great irritability of the heart and arteries, is apt to set in. It is so-called “irritative fever,” combined with anæmia. The quantity of blood in the system being but small, the heart and arteries make violent efforts to supply the deficiency by hurrying what blood there is forward. Hemorrhagic fever, so-called, is marked by the symptoms of great loss of blood, alternating with periods of vascular excitement, the pulse becoming much hurried, fluttering, jerking, and irregular in force and frequency; slight flushings of the face with brilliancy of the eyes appear, rapidly passing again into pallor and syncope; and if, at last, the hemorrhage prove fatal, delirium and convulsions, with extreme restlessness, usually precede the end. (Erichsen.) The symptoms which attend hemorrhagic fever are those of high or inordinate excitation without strength; they ought never to be mistaken for those of inflammation, for they are not attended with increment of the body-heat. Wandering of the mind, or *delirium*, is often present in cases of so-called hemorrhagic fever. It is never violent, but generally of a low muttering character, and is best treated by administering nutrients and stimulants.

Hemorrhagic Convulsions.—Animals that are bled to death usually exhibit bilateral spasms; so, too, in man, epileptiform convulsions are a direct consequence of sudden and copious loss of blood. Some persons are, by nature, much more strongly predisposed to the occurrence of convulsions from loss of blood than others; hence it happens that, in occasional instances, severe convulsions are caused by comparatively small losses of blood. These spasms, called by some *convulsio syncopalis*, are compared by many to those of epilepsy, and are generally considered to be epileptiform in character. The pulse at the wrist may continue deficient or barely perceptible throughout the fit, or it may return long before the close. Hemorrhagic convulsions are not of necessity fatal; generally they are not dangerous; and, for the most part, they yield to the same treatment as ordinary syncope. Great care, however, should always be taken to keep the patient's head in a depressed position as long as they continue. The only fatal cases which I find mentioned by practitioners were of patients improperly treated by further depletion, or who were unwisely raised up into erect postures of body, whereupon syncope, without reaction, ensued.

Great losses of blood also cause a pinched appearance of the face and a shrunken condition of the whole body, for the size of the organism is absolutely lessened by the amount of the blood abstracted from it; and the loss in bulk at the same time falls most heavily, or indeed almost entirely, on the soft parts exterior to the framework of the body. The pinched and exsanguinated appearance which the *cadaver* presents, in cases of death from hemorrhage, cannot be produced from any other known cause.

The constitutional phenomena of hemorrhage, when it is excessive, are very strongly marked, and of themselves are quite sufficient to enable us to diagnose that condition with certainty, even in cases where the extravasation is wholly internal—for example, in the abdominal or thoracic cavity—and where no trace of blood appears on the exterior of the body.

Some persons support the loss of blood much better than others. One adult may swoon on the abstraction of twenty ounces, another will bear the loss of more than forty ounces without swooning. Young and vigorous men may lose a great quantity of blood, and yet rally. Children bear the loss of blood badly, yet they rally quickly. In old age a slight hemorrhage is often of great importance, because the ability to rally is but small. Death from hemorrhage may occur suddenly upon the patient's assuming or being placed in an erect posture, or upon raising up his head, or upon allowing his arms or legs to fall down from the couch; hence all such changes are to be reprobated. Finally, there are fatal instances of hemorrhage in which death is due not so much to the quantity of blood that is lost, as to the association of terror, or of pre-existing disease, or to the influence of a suicidal purpose.

After sudden and exhausting hemorrhages, especially those which are about to prove fatal unless transfusion be promptly employed, the injured arteries are sometimes seen lying in the wounds collapsed, and without exhibiting any signs of pulsation. It is because the waves of blood have not sufficient momentum imparted to them by the heart to reach the severed arteries. During the late war I several times noted this pulseless condition of wounded arteries after great losses of blood, and now, in looking back, I have no doubt that some of these cases might have been saved by the operation of transfusion, if it could have been seasonably performed.

SPONTANEOUS ARREST OF ARTERIAL HEMORRHAGE.

This point of doctrine has much practical importance, and therefore should be discussed in all its details. For Nature to durably stop the bleeding from wounded arteries, it is primarily requisite that the arteries themselves should be completely divided by the accident or the operation. When we closely scan the faces of large wounds, such, for instance, as are made in cutting off limbs, after the first sudden gush of blood is over, we see but little if any flow of blood, except that which comes forth in distinct and plainly visible streams; thus it is evident that the mouths of almost all the multitude of minute vessels shown in well-injected preparations of the tissues, become closed immediately after the vessels themselves are divided. The contact of the amputating knife, supplemented by that of the air, and of cold, induces the muscular fibres at the exposed ends of these vessels to contract so much as to close the small ones completely, and to lessen the size of all considerably. Whatever hinders this contraction of the vessels prolongs and increases the bleeding. Hence large bleedings sometimes issue from the comparatively small vessels that pass through or are connected with firm and close structures, as, for instance, the small arteries in or near the aponeuroses and fasciæ, or in the compact portions of the skin, *c. g.*, that of the face, etc. So, too, in parts which are inflamed, or adjoin the seat of active disease, the dilated vessels bleed largely and long when divided, because of the loss of contractile power in their muscular coats.

Gradually, with or without surgical aid, all the vessels divided in an operation, or accidental wound, become closed and cease to bleed; very frequently also the larger arteries are helped to this end considerably by the retraction of their extremities into the inter-muscular connective tissue, and still more by the formation of coagula within and over their constricted orifices, and by the diminished force of the cardiac contractions and blood-pressure which results from prolongation of the hemorrhage. Coincidentally, the flowing blood becomes gradually brighter and paler. And, if the wound be left open, after pure blood has ceased to flow, there is an oozing of blood-tinged, serous-looking fluid; and this is gradually succeeded by a paler fluid, some of which collects, like a whitish film or glazing, on the surface of the wound. It contains very numerous white blood-corpuscles, imbedded, apparently, in a fibrinous film. (Paget.)

The spontaneous arrest of hemorrhage from divided arteries is brought to pass by the coincident operation of several distinct agencies, which are the following:—

I. CONTRACTION OF THE ARTERY.—*Contraction* of the artery at the place of division ensues, the consequence being that the orifice is either closed completely, an occurrence which generally comes to pass when small arteries are severed; or that the orifice is closed in part, that is, constricted, a result which not unfrequently is attained when large arteries are divided. This closure or constriction of the bleeding orifice, which almost uniformly attends the complete division of small arteries in wounds, is due to contraction of the muscular and elastic fibres belonging to the several coats of the artery which circle immediately round the orifice, under the stimulus of the wound itself, or of the atmospheric air, or of the external cold to which it is exposed. Moreover, the surgeon is not unfrequently called on to assist Nature in stopping arterial hemorrhage by opening and clearing out the wound so as to lay the bleeding apertures completely bare to the action of fresh cool air, cold water,

ice, etc., whereby full contraction of these muscular fibres and consequent closure of the bleeding apertures may at once be obtained.

II. RETRACTION OF THE ARTERY.—*Retraction* of the ends of the severed artery into its sheath, and into the loose connective tissue by which arteries and their sheaths are not unfrequently surrounded, likewise ensues. But it does not follow the complete division of arteries with anything like the same uniformity as contraction of the cut extremities. It is often inconsiderable, and sometimes even does not take place. For instance, I have seen in a wound of the palm of the hand where a branch of the radial artery was divided, the two ends of the injured vessel not retracting, but, in fact, projecting somewhat from the surface, so as to be easily taken up and tied. I have also seen very nearly the same thing occur in wounds of the scalp, and in wounds of the face. But when the severed artery is not surrounded by dense structures, when it is situated between the muscles and not in the substance of any of them, and the connective tissue around it is quite lax, then the two ends retract very sensibly, and become buried, as it were, in the flesh. When retraction such as this occurs, it renders the escape of blood much more difficult, and thus assists materially in suppressing hemorrhage. The retraction of severed arteries is also due solely to the action of the muscular and elastic tissue in the several coats; and, generally, it does not take place as early or as promptly as the constriction of the cut extremities.

III. COAGULATION OF THE BLOOD.—When the orifices are not completely closed by contraction of the muscular coat, the blood may *coagulate* as it escapes from these orifices, and thus fill the part of the wound external to the cut ends of the artery with a firm clot called the *external coagulum*; and, likewise, may fill up or plug the constricted ends of the artery with a firm clot called the *internal coagulum*. Thus arterial bleeding may be, and not unfrequently has been, completely suppressed; and when the internal coagulum becomes organized, the bleeding remains permanently arrested, and the arterial canal at the place of injury becomes obliterated.

IV. INCREASED COAGULABILITY OF THE BLOOD.—As the hemorrhage progresses and syncope approaches, the tendency of the blood to coagulate is very much augmented; and this acquired quality of the blood often assists not a little in the process of natural hæmostasis.

V. DIMINISHED FORCE OF THE HEART.—Diminution of the force with which the heart contracts, as the loss of blood increases, also facilitates very much the occurrence of natural hæmostasis. The vigorous manner in which the jet of blood is thrown by each contraction of the left ventricle, is the principal obstacle to the formation of blood-clot around and within the cut vessel; for not only does the movement of the blood prevent coagulation, but, as long as the jet is more powerful than the cohesion of the clot, it will certainly wash the coagulum away. As the blood flows, and the heart's impulse becomes gradually lessened in force, the jet becomes lower and lower, until at last, when faintness comes on, it is almost entirely arrested, and time is afforded to form and consolidate a coagulum which shall permanently close the aperture in the wounded artery.

PHENOMENA OF SPONTANEOUS ARREST OF ARTERIAL BLEEDING.—The spontaneous arrest of hemorrhage from such arteries as the radial and ulnar, when wounded, is attended with the following phenomena:—

"In many cases of amputation at the wrist and forearm," says Guthrie, "in which I wished the patient to lose a certain quantity of blood, I have allowed either the radial or ulnar artery to bleed until it ceased. At first, the jet appears interrupted, then the stream becomes continuous, although projected further at each systole of the heart. As the orifice contracts, the flow of blood becomes more equal, it is thrown to a less distance, the size of the stream is smaller, and it goes on diminishing until it only oozes out, and then soon ceases; the extremity of the vessel being covered by a layer of coagulum of greater or less thickness. The experiment may be made every day upon the temporal artery, with this addition, that as the stream diminishes let a filip with the nail be given to the extremity of the vessel, when the jet will become a little larger; and this may be done several times, until at last it fails to have any effect, and the hemorrhage ceases. In none of these instances could the retraction of the artery be fairly estimated, although it appears from analogy, and from what is seen to occur in other cases, that a certain degree of it must have taken place. In similar cases, in which I have been able to make an examination either after death or amputation, the contraction [but not the retraction] of the vessel was evident, as well as the formation of a very slight external coagulum, extending into the canal of the artery. The sheath of the artery could do nothing, because there was none; neither did the internal coagulum, which, at this period, strictly speaking, does not exist. In small vessels, such as the radial or ulnar arteries, I do not believe anything depends on the diminished power of the circulation; but when the axillary and femoral arteries are divided, the shock of the injury and the loss of blood powerfully contribute to the suppression of hemorrhage."¹

Guthrie's observations concerning the absence of retraction in such arteries as the radial and ulnar in the lower third of the forearm, together with the anterior temporal and facial, etc., when divided in wounds, agree pretty closely with what I have seen. But when large arteries that are invested with sheaths, and are likewise imbedded in loose connective tissue, for instance, the brachial, axillary, femoral, etc., are divided completely in shot-wounds, and they cease to bleed spontaneously, which sometimes happens, and several examples whereof will hereafter be presented, the retraction of the ends becomes quite strongly marked and noteworthy. Of such cases Dr. Jones has furnished an excellent description:—

An impetuous flow of blood, a sudden and forcible retraction of the artery within its sheath, and a slight contraction of its extremity, are the immediate and almost simultaneous effects of its division. The natural impulse, however, with which the blood is driven on, in some measure counteracts the retraction, and resists the contraction of the artery. The blood is effused into the cellular substance between the artery and its sheath, and, passing through that canal of the sheath which has been formed by the retraction of the artery, flows freely externally, or is extravasated into the surrounding cellular membrane, in proportion to the open or confined state of the external wound. The retracting artery leaves the internal surface of the sheath uneven, by stretching or lacerating the cellular fibres that connected them. These fibres entangle the blood as it flows, and thus the foundation is laid for the formation of a coagulum at the mouth of the artery, which appears to be completed by the blood as it passes through this canal of the sheath, gradually adhering and coagulating around its internal surface till it completely fills it up from the circumference to the centre.

A certain degree of obstruction to the hemorrhage, which results from the effusion of blood into the surrounding cellular membrane, and between the artery and its sheath—but particularly the diminished force and velocity of the circulation, occasioned by the hemorrhage, and the speedy coagulation of the blood which is a well-known consequence of such diminished action of the vascular system—most essentially contribute to the accomplishment of this important and desirable effect.

A coagulum, then, formed at the mouth of the artery, and within its sheath, and

¹ Diseases and Injuries of Arteries, pp. 225, 226.

which I have distinguished in the experiments by the name of the *external coagulum*, presents the first complete barrier to the effusion of blood. This coagulum, viewed externally, appears like a continuation of the artery; its termination can be distinctly seen with the coagulum completely shutting up its mouth, and inclosed in its sheath.

The mouth of the artery being no longer pervious, nor a collateral branch very near it, the blood just within it is at rest, coagulates, and forms, in general, a slender conical coagulum, which neither fills up the canal of the artery nor adheres to its sides, except by a small portion of the circumference of its base, which lies near the extremity of the vessel. This coagulum is distinct from the former, and I have called it the *internal coagulum*.

In the mean time the cut extremity of the artery inflames, and the vasa vasorum pour out lymph, which is prevented from escaping by the external coagulum. This lymph fills up the extremity of the artery, is situated between the internal and external coagula of blood, is somewhat intermingled with them, or adheres to them, and is firmly united all round to the internal coat of the artery.

The permanent suppression of the hemorrhage chiefly depends on this coagulum of lymph; but while it is forming within, the extremity of the artery is further secured by a gradual contraction which it undergoes, and by an effusion of lymph between its tunics and into the cellular membrane surrounding it; in consequence of which these parts become thickened, and so completely incorporated with each other, that it is impossible to distinguish one from the other; thus, not only is the canal of the artery obliterated, but its extremity also is completely effaced, and blended with the surrounding parts.

When the wound in the integuments is not healed by the first intention, coagulating lymph, which is soon effused, not only attaches the artery firmly to the subjacent and lateral parts, but also gives it a new covering, and completely excludes it from the external wound, which then goes on to fill up and heal in the usual manner.

The circumstances now described are observed also in the inferior portion of the artery, or that which is supplied with blood by anastomosis; with this difference only, that its orifice is generally more contracted, and the external coagulum is much smaller than the one which adheres to the mouth of the superior portion of the artery, or that from which the blood flows in its direct course from the heart.

From this view of the subject we can no longer consider the suppression of hemorrhage as a simple or mere mechanical effect, but as a process performed by the concurrent and successive operations of many causes; these may briefly be stated to consist in the retraction and contraction of the artery; the formation of a coagulum at its mouth; the inflammation and consolidation of its extremity by an effusion of coagulable lymph within its canal, between its tunics, and in the cellular substance surrounding it.¹

When the arm is torn off at the shoulder, the bleeding often is but slight, and ceases spontaneously, because the internal and middle coats of the arteries are broken off short, while the external coat and sheath are dragged down and twisted over the torn ends of the arteries in such a way as to afford a ready lodgment for an occluding coagulum or plug, whereby the further outflow of blood is prevented. In such cases the arteries may be seen hanging out of the wounds, and pulsating down to their very ends, which are usually contracted to mere points, the hemorrhage, at the same time, being completely suppressed. In such cases it may also be observed, that with every pulsation the end of the torn artery is thrust downwards, but that it recoils again during the intervals between the pulsations. This fact proves that arteries are endowed with extensibility and elasticity, as well as with contractility and retractility. The details of this subject given above, although numerous, are drawn wholly from the experience of competent observers, and their presentation has been deemed necessary for a correct understanding of the different ways in which Nature suppresses hemorrhage from arteries both small and large.

It is not difficult to understand why hemorrhage is much more apt to cease

¹ On Hemorrhage, pp. 53 *et seq.* London, 1805.

spontaneously when arteries are completely, than when but partially divided. In the latter case the injured part of the artery cannot contract in such a way as to lessen the size of the aperture; but, on the contrary, the contraction of the muscular and elastic fibres involved generally causes the aperture to gape open, and thus when an artery is but partially divided, the bleeding orifice is usually enlarged instead of being lessened by the arterial contractility; and the flow of blood therefore is promoted rather than lessened thereby. Again, when partial division takes place, the injured part of the artery cannot be withdrawn or retracted into the sheath, and thus the external coagulum, when formed, is much less likely to have a foothold which will secure it from ejection when the pulse rises after the depression of syncope passes away. Furthermore, when an artery is but partially divided, the formation of an internal coagulum, spontaneously, is impossible. The continuity of the vessel being still preserved in greater or less degree, in inverse proportion to the extent to which the division has been carried, the current of blood in the canal is not retarded or stagnated sufficiently for coagulation to occur. It continues to flow through or past the opening made by the wound in a wave-like stream; and any small clots which might form would be swept away in the current. Hence, too, it sometimes happens that when small arteries, such as the radial, ulnar, and temporal, are partially divided in accidents or attempts at self-destruction, the resulting hemorrhage proves fatal unless stopped by art.

In discussing the spontaneous arrest of hemorrhages, it should also be mentioned that the parts external to the wounded artery sometimes furnish valuable assistance to this end. If, for instance, the opening through them be valvular, they may afford an excellent support to the external coagulum. If the track of the wound be narrow and ragged, as well as oblique, a backing to the external coagulum that is still better will be furnished.

When wounded arteries are plugged by foreign bodies, such as bullets, pieces of equipment, clothing, etc., the primary bleeding is sometimes thoroughly restrained thereby, as happened in the following instance:—

At the Washington Infirmary, August 15, 1861, through the courtesy of Dr. J. W. S. Gouley, I had the opportunity of examining a very instructive preparation of the left common carotid artery and contiguous parts, obtained on the previous day at the autopsy of a soldier who had died of secondary hemorrhage from a gunshot wound of the left side of the face and neck, received fourteen days before the hemorrhage occurred.

The missile was the old or round musket-ball; it struck the lower jaw, well forward, when nearly spent, and was deflected downward, backward, and slightly outward, in such a way as to pass obliquely through the left common carotid artery, and to lodge in the tunics and sheath of that vessel underneath the omo-hyoid muscle, pressing somewhat upon the par vagum, and occluding completely the proximal end of the divided artery. The hemorrhage came on suddenly and without any premonition, two or three days after entering the hospital, and fourteen days after the casualty. The bleeding was very profuse; the patient lost more than a quart of blood, which flowed in a great stream from his mouth. An attempt to tie the common carotid above the omo-hyoid muscle was made, but it had to be abandoned on account of the great profuseness with which blood flowed into the wound of operation, rendering a continuance of the search for the wounded artery impossible. It was believed by all the surgeons present that the patient was now so much exhausted from loss of blood as to make it useless to attempt to tie the common carotid artery below the omo-hyoid muscle; and death followed the next morning. Moreover, the source of the hemorrhage was not suspected, until the autopsy revealed it. The autopsy showed, among other things, that the dis severed common carotid artery was still occluded, on the side of the wound toward the heart, by the impacted ball; that a false aneurism as large as a filbert and elongated in shape had been formed at the distal extremity and on the inner side of the

dissevered artery, just above the omo-hyoid muscle; that the hemorrhage occurred from rupture or spontaneous opening of the sac of this traumatic aneurism; that the hemorrhage was not direct, but regurgitant in character, inasmuch as the escaping blood flowed backward, that is, toward the heart, through the distal portion of the artery; and that the hemorrhage could not have been arrested without tying it on the distal side of the wound. The ligation of the common carotid below the omo-hyoid muscle would, therefore, not have done any good, unless the vessel had at the same time been tied above or on the distal side of the wound and aneurism. The aneurism itself constituted a remarkable, and, as far as I know, a unique feature of this case, because it was developed from the distal end of the artery; and its occurrence can only be explained on the assumption that the communication between the carotids and vertebrals through the circle of Willis was unusually free.

Another case in which bleeding from an artery torn by gunshot was prevented by the bullet, has been reported by Dr. Dewitt C. Peters, U. S. Army.¹ The right vertebral artery was extensively lacerated at the point where it passed through the foramen of the transverse process of the atlas; the ball resting there probably acted as a plug, and thus restrained hemorrhage.

GENERAL CONSIDERATIONS CONCERNING THE TREATMENT OF SURGICAL HEMORRHAGE.

When the wounded vessel is superficial, that is, near the surface of the body, it is generally easy to determine that the blood issues from an artery rather than from a vein, by calling to mind the relative anatomy of the part, by actual inspection of the bleeding orifices, and by observing that the blood is bright-red and flows *per saltum*, instead of flowing in a continuous, dark-red stream. But, when the blood issues from deep-seated vessels whose positions correspond to both arteries and veins of considerable magnitude, it is not always so easy in practice, to determine from what vessels it proceeds. The admixture of arterial blood which must always flow to greater or less extent into the track of the wounds leading down to deeply-seated veins, may suffice to tinge the effusion with a brighter hue than that which belongs to venous blood; while on the other hand, the blood issuing from wounded arteries may rise to the surface mingled with much venous blood, and correspondingly darkened in color thereby. There are, too, various obstructions which often prevent, in deep wounds, the issue of blood from arteries in jets, synchronous with their pulsations; and when anæsthetics are freely administered, but especially when their administration is continued for considerable time, the color of the blood becomes greatly changed, so that in many instances the arterial cannot be distinguished by this test alone from the venous blood. Moreover, the blood which flows from the distal orifice in a severed artery is, for the most part, much darker than that which flows from the proximal orifice; and it often issues in a continuous stream from the distal orifice like that which flows from a wounded vein.

In some cases, therefore, we cannot at the first glance determine the source of the bleeding. In such cases valuable aid may sometimes be derived from compressing the main artery firmly on the cardiac side of the wound. If the hemorrhage be arrested by this procedure, it is certain that the bleeding is arterial; but if the hemorrhage be increased by this procedure, it is equally certain that a wounded vein is the principal source of the bleeding. Sometimes, however, from the presence of inflammation, or from want of room, or from some other cause, it happens that the main artery cannot be successfully

¹ American Journal of the Medical Sciences, April, 1865, pp. 373, 374.

compressed on the cardiac side of the wound. In such cases valuable or even decisive information may be obtained by exploring the wound with a finger; for thus the surgeon can feel the blood issuing in jets when it proceeds from the open mouth of an artery.

As already stated, I am convinced from my own observations, that a very large proportion of the persons killed in battle perish directly from loss of blood. On March 25, 1865, I examined the bodies of *forty-three* Confederate soldiers, killed in the assault on Fort Steadman, on the ground where they had fallen, in the lines before Petersburg. *Twenty-three* of them had been shot in the head; *fifteen*, in the chest; and *five*, in the abdomen. The blanched and exsanguinated appearance of the cadaver in the case of every one wounded in the abdomen, showed clearly that death had been caused by hemorrhage; and the extreme rapidity with which the result had followed the wound implied that some large bloodvessel had been opened. In the cases of all but two or three of those wounded in the chest, the body presented the peculiarly blanched appearance belonging to death from loss of blood. There was much blood in the clothing and on the ground where these men had fallen, in most instances where the trunk was wounded, and in some where the head was wounded. This circumstance shows that the hemorrhage was often external as well as internal. It is not improbable that in some cases where the cadaver did not present a blanched appearance, death was indirectly caused by traumatic extravasation of blood into the cavity of the chest, or that of the cranium, whereby the brain or the lungs sustained a compression which soon proved fatal. On June 8, 1862, Private Wallace Fairchild, Co. K, 106th Pa. Vols., was wounded in a skirmish at the rifle-pits near Fair Oaks, Va., by a sabre-bayonet, in the left thigh, the femoral artery being divided; this soldier bled to death before surgical attendance could be had. On the next day, June 9, Private Charles Riley, Co. G, 71st Pa. Vols., was shot through the neck by a musket or rifle ball, while on picket-duty near Fair Oaks, Va., and died of hemorrhage in a few minutes. Both cases were reported under the head of "killed," as death occurred on the field very soon after the mishap, and before removal could be effected.

My own experience in this regard does not differ much from that of others. Major Richard Lanning, 80th Ohio Vols., received at Corinth, October 3, 1862, a gunshot wound. The missile passed through his neck, just in front of the carotid artery. He died on the field, from hemorrhage.¹ The late Dr. Otis personally made "an aggregate of seventy-six observations of the bodies of the slain, on the field" of battle. The mortal wound was in the head in *twenty-seven*; in the neck in *four*; in the chest in *thirty-two*; in the abdomen in *nine*; and in the thigh in *four* instances. In the New Zealand War of 1863-5, of one hundred and eighteen men who were killed in battle, *forty* were wounded in the head; *four* in the neck; *fifty-nine* in the chest; *eleven* in the abdomen; and *four* in the thigh.² Guthrie states that General Sir Edward Paakenham received a wound directly through the common iliac artery, at New Orleans, which killed him on the spot, and that Colonel Duckworth, of the 48th Regiment, received a ball through the edge of his leathern stock, at Albuhera, which divided the carotid artery, and killed him almost instantaneously. I am, therefore, led by the observations of others, as well as by my own experience, to believe that a very large proportion, probably one-half, of those slain in battle, die either directly or indirectly from hemorrhage.

Now, an inquiry of much practical moment suggests itself, viz.: What

¹ Medical and Surgical History of the War of the Rebellion. First Surgical Volume, p. 411.

² Ibid., p. 603.

efforts should be made to arrest the hemorrhage in desperate cases, such as those just mentioned? On this point the following examples will shed some useful light:—

At San Antonio, Texas, in the month of August, 1865 (as Dr. Sanford B. Hunt, late Surgeon U. S. Volunteers, informs me), Lieutenant Van Giesen, of the 18th N. Y. Cavalry, was accidentally wounded by a pistol in the hands of a comrade. The muzzle of the pistol was not more than three feet from the point where the ball entered, which was on the right side of the neck, immediately opposite the superior border of the thyroid cartilage, and directly over the origin of the external carotid artery. The point where the ball escaped was on the posterior part of the neck. The hemorrhage was great, being sufficient to render the injured man very pallid and faint, but was promptly checked by an intelligent bystander by compression effected with the thumb applied in the wound. The first surgeon to reach the case was Dr. Settle, formerly Medical Director of the Confederate Army in Texas. On withdrawing the compression, as Dr. Settle informed Dr. Hunt, the hemorrhage was renewed, a stream of blood as large as a crow-quill being thrown through the centre of a partially-formed clot to a distance of more than two feet, *per saltum*. It must have been over an hour after the wound was inflicted when I saw him (says Dr. Hunt). On again withdrawing the compression, no hemorrhage occurred. It was then ten o'clock P. M.; the patient lay on the ground out of doors; good light could not be procured, and it was decided to defer the operation. An assistant surgeon was left with the patient, the instruments, etc., were put in readiness, and I expected to ligate the common carotid next morning, or perhaps during the night.

Next morning, however, the clot was firm, no hemorrhage occurred, and the policy of delay was adopted. About the eighth day the clot softened, and came away without hemorrhage; the wound rapidly healed with hardly any perceptible suppuration (the ball had passed out posteriorly), and complete recovery resulted without operative procedure. After recovery there was no pulsation in the temporal artery of that side, and some coldness and numbness of the face existed for a time.

Again, in the summer of 1864, in front of Petersburg, an officer belonging to the Army of the Potomac (I think that the officer was Assistant Surgeon R. S. Vickery, 2d Michigan Volunteers) was wounded by a rifle-ball which divided the femoral artery in the upper part of its course; the hemorrhage was very profuse; but he had the presence of mind to compress the wounded vessel with his own fingers, and thus stay the bleeding, until he could be taken to a surgeon, who applied ligatures. This officer made a good recovery.

Furthermore, Dr. T. F. Azpell, U. S. Army, related to me a case in point which came under his own observation during the war of the Rebellion; the axillary artery of a soldier was wounded near its origin by a rifle-ball; the hemorrhage, which was very abundant, was arrested immediately by digital pressure, and was thus restrained until a ligature could be applied to the subclavian artery; this patient, too, got well.

In addition to the above cases may be mentioned that reported by the elder Larrey, of General Arrighi, Duke of Padua, who was struck in the neck by a musket-ball at St. Jean d'Acre. It wounded his right carotid artery, the hemorrhage was very profuse, and he must have died from it on the spot, if a soldier had not had the presence of mind to stop the bleeding by introducing his two forefingers into the wound, and keeping them there until Larrey arrived, who tied the wounded artery with a good result.

Digital compression, then, if brought to bear by introducing the fingers or thumb into the wound, and applying them directly to the bleeding orifices of artery or vein, may not unfrequently be employed with success to stay the hemorrhage until ligatures can be applied, in wounds of the neck, arm-pit, groin, extremities, etc., which otherwise would soon prove fatal from loss of blood. And digital compression may sometimes be applied in this way by the patient himself, as well as by a comrade or bystander; for the amount of pressure required to stop the bleeding from even a large artery is surprisingly small, when it is placed directly and held steadily upon the orifice itself of the wounded vessel. A knowledge of these facts should be widely

disseminated among the laity as well as the profession, for no consequences but good ones can result therefrom. Under any circumstances, efforts should be promptly and perseveringly made, whenever practicable, to stay the hemorrhage in all desperate cases by compressing the opened artery or vein with fingers in the wound, according to the method shown above, until surgical attendance can be obtained and ligatures properly applied. Had such a course been adopted in the cases of Privates Fairchild and Riley, mentioned above, and in several others of which I have personal knowledge, it is not too much to say that their lives might have been saved.

Gunshot wounds of any region of the body do not, in general, bleed as freely as incised wounds of the same region, that are similar in depth and extent. This difference is occasioned by the fact that the former are, for the most part, contused and lacerated in their nature. It is well known that when bloodvessels are severed by either a contusing or a lacerating force, the disposition to hemorrhage is considerably lessened by the form of the injury. When limbs are torn off by machinery, or crushed off by railway carriages, or carried away by cannon-balls, the loss of blood is not always so great as to prove fatal. In such cases the bleeding, which at first is very profuse, often ceases with the occurrence of syncope, and afterward does not recur to any considerable extent. If we examine the bruised and torn stump of a limb which has just been severed by a cannon-ball, we find that the smaller arteries give issue to but little if any blood, because their extremities are more or less completely closed by being blended with the crushed mass of muscular and connective tissue in the first place, and by the natural contraction of their muscular and elastic tissues in the second place. The main arteries in such cases may sometimes be seen hanging out of the ragged stumps, and pulsating down to their ends, which, however, are closed more or less completely by their contraction, and, generally, by the presence also of plugs of coagulated blood within the constricted orifices, which may perfect their occlusion. But the completeness of their closure accords in many instances with the lapse of time after the injury, being found to be more thorough after a considerable than after a brief interval. Thus we perceive that cases of contused, or of lacerated, or of gunshot wounds of arteries, may sometimes admit of delay in respect to surgical treatment, which would be wholly inadmissible in cases of incised wounds of the same arteries.

When wounds have been properly dressed, especially those that implicate large bloodvessels—for instance, wounds of the armpit involving the axillary artery or vein, wounds of the neck compromising the carotids or the internal jugular, wounds of the groin involving the common femoral artery or vein, etc.—much wariness should be exercised in regard to disturbing the dressings, unless there be a return of the bleeding; and even then, preparations should be made beforehand, and everything should be got ready to meet any possible emergency in the shape of hemorrhage bursting forth from the wound as soon as the bandage and compresses are taken off. Nothing can be more reprehensible than to disturb, from mere inquisitiveness, the dressings of a wound in which a great hemorrhage has just been arrested. As long as the parts are dry and quiet, they should generally be let alone until the normal discharges begin to loosen the dressings. By that time the processes of adhesion may have permanently closed the orifice in the wounded artery or vein, and thus all secondary bleeding may be prevented.

During the riots in Southwark (says McClellan), I dressed a horrid cannon-shot wound in the right groin of a young soldier from Germantown. He had been struck there by a broken piece of cast iron, with the fragments of which one of the cannon in the hands of the mob had been loaded. The whole fore-part of the fleshy substance of

the groin, in contact with Poupart's ligament, had been torn away, and a prodigious rent made across the artery, with a hole in the vein. He had flooded the floor, on which he lay, with gore, and was deadly faint when I arrived. It was late at night, and the rioters were all around. I, therefore, applied graduated compresses, and bound them down with a spica bandage. But it required two hours' constant nursing, with his head and shoulders in my lap below the bedside, and the incessant use of cordials and brandy, to revive him. During his reaction the poor fellow was delirious, and wanted to go home. He had no return of hemorrhage, however, and by morning I got him so far recovered as to have him transported in a carriage to one of the hospitals. There, however, somebody stripped off his bandage and pulled away the compresses, to see how I had dressed the wound. The blood gushed out in a torrent, and a second fainting process carried off the patient.¹

But, although the primary dressings should never be disturbed from motives of idle curiosity, especially in cases where the patient has already been brought low by hemorrhage, still instances not unfrequently occur where it is the bounden duty of the surgeon to re-open the wounds as soon as practicable, and secure by ligatures, or by other effectual means, the open mouths of the wounded vessels; for instance, when the femoral artery is punctured by a penknife-blade, and blood is being more or less widely extravasated in the loose connective tissue between the muscles of the thigh; or the internal epigastric artery has been opened by a penetrating wound of the belly, and blood is flowing internally into the abdominal cavity; or the intercostal or internal mammary arteries are wounded, and blood is pouring therefrom into the pleural cavities—the dressings should be removed without delay, and well-directed efforts should be persistently made to stop the internal bleeding. To the femoral and internal epigastric arteries, ligatures should be applied on each side of the bleeding orifice. The intercostal and internal mammary arteries should also be tied if possible; but, in case of failure to ligate them, the bleeding should be stopped by Desault's pad or tampon, the preparation and application of which will shortly be described.

CHEMICO-VITAL TREATMENT OF SURGICAL HEMORRHAGE.—The chemico-vital agents which may be employed for the suppression of hemorrhages are very numerous, and are denominated chemico-vital hæmostatics. But such, only, should be selected for use by the surgeon, as imitate, hasten, or assist the natural processes of hæmostasis, or excite analogous ones: that is, such as act by arousing the contractility and retractility of the coats of arteries and veins and capillaries, thus lessening the size of the apertures; or, by forming occluding coagula artificially, thus plugging and closing the apertures completely; or, by exciting adhesive inflammation within and around the apertures, thus making their closure permanent. The most important of these hæmostatics will be enumerated.

I. COLD.—The employment of cold has been handed down from ancient times. Celsus directs it to be used for stopping hemorrhage. Rhazes advises the application of snow for the same purpose. John Hunter saw the carotid artery of an ass markedly lessen when exposed. Baron Larrey states that, after the battle of Eylau, the mercury standing at about zero (Fahr.), ligatures were applied to the large bloodvessels only, in the operations generally, and that there was no trouble from hemorrhage, although the wounded, after having been cared for, were carried to a great distance.² In the use of cold, then, we have an ancient, handy, safe, and powerful means for arresting bleeding. It may be applied in the form of fresh cold *air*. Merely opening

¹ Op. cit., p. 185.

² Memoirs, vol. ii. p. 32, Am. ed.

a wound, removing the clots, and exposing its bare surface to the contact of fresh cold air, has often stopped at once a hemorrhage which had continued to be free, as long as the wound was kept closed and covered up with pledgets and bandages. Wounds are often left open for a considerable time solely for the purpose of obtaining the hæmostatic influence of the atmosphere. The energy of atmospheric cold may be considerably increased by fanning the exposed part. Cold may also be applied in the form of water or of ice. Compresses soaked in cold *water* may be laid on, and, when frequently renewed, they exert a powerful hæmostatic influence. Cold water, too, may be squeezed from the pores of a sponge in showers upon a wound; or, it may be thrown in a small steady stream from the nozzle of a syringe. This plan usually effects rapid contraction in the small vessels that are wounded, and thus quickly stops their bleeding. Sometimes, in operations about the air-passages, it is especially important to employ cold water thrown in a fine stream upon the incision, with a small syringe. Finally, cold may be applied in the form of *ice*. When hemorrhage occurs within the cavity of the uterus, or of the rectum, or of the mouth, suitably shaped fragments of ice may often be laid, with great advantage, directly upon the bleeding surface. In cases where dry cold of great intensity is required, it may readily be obtained by placing pounded ice or freezing mixtures in bladders or India-rubber bags adapted for the purpose.

II. ALCOHOL.—Applied to a raw surface, alcohol excites a severe smarting pain, with a considerable contraction of the wounded bloodvessels; it also coagulates the blood itself. As an external application alcohol, in a natural or an artificial form, has, from remote antiquity, been used as a dressing for wounds. The ancient use of oil and wine for this purpose is well known. In the seventeenth and eighteenth centuries, alcohol was extensively employed as a dressing for incised and other clean wounds, and its ability to suppress bleeding was then noted. Recent observations also attest its excellence in arresting hemorrhages, by causing the wounded vessels to contract, and by coagulating the albumen of exuded plasma. It may be applied in the form of rectified spirit, by moistening a soft sponge therewith, and gently pressing it upon the bleeding surface. Alcohol is also useful for dressings to wounds in other respects, for it prevents the putrefaction of discharges, and promotes cicatrization.

III. OIL OF TURPENTINE.—John Hunter termed this “the best, if not the only true styptic,” and its efficacy justifies this high estimate of its value. In external traumatic hemorrhages it has proved efficient; and it has been used with success in almost every other form of hemorrhage. It has been used with most success, however, in cases where the bleeding was passive. The particular affections for which it has been successfully prescribed are *epistaxis*, *hæmatemesis*, *hæmaturia*, *menorrhagia*, *post-partum bleeding*, and the multiple bleedings occurring under the influence of the *hemorrhagic diathesis*. It acts by arousing the contractility of the vessels that are opened and bleeding. It may be used internally as well as externally with advantage. It may be applied by saturating dossils of lint, and placing them upon the bleeding points. Internally, it may be administered in doses of ten or fifteen drops suspended in mucilage, emulsion, or yolk of egg, every hour or two, until relief is obtained. By giving ten drops, in simple emulsion, every fifteen minutes, I once saved a case of prolonged epistaxis that had been considered almost hopeless. The liability of turpentine to irritate the bladder should not be forgotten.

IV. PERCHLORIDE AND PERSULPHATE OF IRON.—Solutions of these acid salts of iron have been much employed for arresting hemorrhages. Both preparations are powerfully astringent and hæmostatic. The perchloride, however, is the more irritating. It is of interest to learn, if possible, in what manner its solution acts in suppressing hemorrhage. Undoubtedly it coagulates the blood itself. When a small artery is allowed to bleed into a saucer containing a mixture of two parts of the liquor ferri perchloridi and one of water, this mixture converts almost at once six or eight times its bulk of blood into a tough, hard clot, and for a long time preserves it from putrefaction. But Broca has shown that this coagulating action is not instantaneous, but requires about thirty seconds for its completion; so that if this mixture, or any other solution of ferric chloride, be applied to a part from which the blood is flowing freely, its styptic influence cannot be exerted upon the vessels themselves from which the blood escapes. But such an influence is essential to the satisfactory arrest of a hemorrhage. Dr. Barnes, who first brought this remedy into vogue, employed a mixture of one part of the stronger solution of ferric chloride and three parts of water, which he applied, by injecting it through a tube, directly to the bleeding surface of the uterus. As a hæmostatic for external use, five parts of the salt may be dissolved in one hundred parts of distilled water, and lint soaked with this mixture may be applied to the bleeding surface.

But Monsel's solution of the persulphate of iron has probably been used, in this country at least, as a local hæmostatic, much more than the ferric chloride. It has the advantage of being less irritating than other acid salts of iron. It has been applied by a stiff brush, or a fragment of compact sponge; or by laying a pledget of lint soaked with the solution, upon the bleeding surface.

Both of these preparations, however, have been more popular than they have deserved to be. Neither of them directly or immediately excites the opened vessel to contract. Both of them, also, as well as the other acid salts of iron, produce a hard insoluble coagulum, which is very difficult to detach, and which greatly interferes with the apposition and healing of all deep wounds where these substances have been applied. Their employment is, therefore, to be deprecated in all surgical hemorrhages except those which are tegumentary or superficial, as for instance, those caused by leech-bites; but to them, the solutions of these ferric salts may be applied with advantage. They may also be used with much benefit in cases of parenchymatous hemorrhage occurring in open wounds.

There are many other astringent substances which coagulate the blood, and may thus suppress hemorrhage by filling with clot the wound from which the blood issues, that is, by plugging it. Among them the most important are *tannic* and *gallic acids*, *alum*, *nitrate of silver*, and *chloride of zinc*. But they are all liable to the same objections as the acid salts of iron, which have just been explained. Alum, however, is the least objectionable. It should be dissolved in warm water, and applied in a tepid state, for then it will be deposited in fine crystals about the mouths of the opened vessels. A sharpened stick of nitrate of silver too, may sometimes be applied with advantage for arresting hemorrhage in leech-bites. But, I believe that in all deep wounds, the employment of astringent substances, whether mineral or vegetable, excepting perhaps alum and alcohol, ought to be shunned, because the occluding coagula which they produce interfere not a little with the apposition and healing of such wounds.

Besides the oil of turpentine, there are several other agents which, when given internally, are useful for suppressing hemorrhage. They are the *oil of*

erigeron, the *acetate of lead*, *opium*, *dilute or aromatic sulphuric acid*, and *ergot*. They act by causing the wounded vessels to contract. The *Oleum Erigerontis Canadensis* is a nervo-vascular excitant which may be administered in doses of ten or fifteen drops every two or three hours. The plumbic acetate is very widely applicable and effective as an internal hæmostatic. For such a purpose, the dose of acetate of lead should not be less than two grains every hour; and, generally, it should be combined with opium. As much as five grains every hour has been used successfully, and without damage. Opium proves useful by allaying pain and nervous excitability, as well as by causing vascular contraction. It should be given in small doses at short intervals, as, for instance, half a grain every two hours. The diluted and the aromatic sulphuric acid have often been given with good effect for hemorrhages from the portal system, in doses of fifteen drops largely diluted with water, every two or three hours. Ergot is now popular as a hæmostatic. The best form of it for administration is the fluid extract, of which thirty or forty drops may be given every half hour until relief is obtained.

SURGICAL TREATMENT OF HEMORRHAGE.

Under this head, the mechanical expedients employed for suppressing hemorrhages will be severally described. They are (1) position, (2) compression, (3) ligation, (4) torsion, (5) constriction, (6) acupressure, (7) aërteriversion, and (8) cauterization.

I. POSITION.

On lifting up or raising a thigh-stump after amputation, I have often noticed that the bleeding from the femoral vein generally ceases at once, and that, on depressing it again, the bleeding may recur. Thus by position the force of gravitation may be employed to lessen the tendency of blood to flow from wounded vessels. The wounded part should generally be elevated by placing it upon an inclined plane, or a pillow, or a cushion, of suitable height. This proceeding has considerable value in the treatment of venous hemorrhage, especially that which occurs in the lower extremity.

The position of *extreme flexion* is worthy of notice, as well as the elevated position. The acute angle in the course of the main artery which the extreme flexion of a limb occasions, presents a considerable obstacle of a mechanical nature to the flow of blood through the bent artery. This plan has been successfully employed in the treatment of aneurism. It may also be used to restrain hemorrhage from wounds near the hand or foot, and is accomplished by forcibly bending the forearm upon the arm, or the leg upon the thigh, or the thigh upon the abdomen, and so retaining them by several turns of a roller. This position, however, is always uncomfortable, and sometimes intolerable, to the patient, and, therefore, should be employed as a hæmostatic only temporarily, or from want of better means.

On the occurrence of *convulsio syncopalis*, or even of syncope from extreme loss of blood, a depressed position of the patient's head must be constantly preserved until recovery takes place. Moreover, in such cases, the limbs must not be allowed to fall down from the couch, and thus assume a depending position, for the sinking of blood into them by the force of gravitation would notably increase the cerebral anæmia, and the danger of a fatal issue.

II. COMPRESSION.

This mode of treatment consists of applying to the bloodvessels a sufficient degree of pressure to stop the circulation through them, or to prevent the escape of blood from their open mouths, when wounded.

The compression is called *lateral*, when the pressure acts upon the sides of bloodvessels, and perpendicularly to their length or course.

It is denominated *direct*, when the pressure is made upon the ends of divided bloodvessels, or within the apertures of those that are wounded, in a line coinciding with their length or course.

It is styled *immediate*, when the means or the instrument through which the pressure is exerted acts upon the bleeding orifice itself without the intervention of anything else, that is, immediately. By many this mode of compression is also called direct.

It is entitled *mediate* compression when the pressure is brought to bear upon the vessels through intervening tissue or soft parts.

Lateral compression may be made on a bloodvessel at the place where it is wounded, or between it and the heart; or, again, it may sometimes be required beyond the wound, that is, on the distal side thereof. Lateral compression, when applied to arteries, pushes them before it, and crowds them into the soft structures upon which they rest. Now, if these structures have no solid support, they yield; thus the compression is evaded, and it proves insufficient to arrest the flow of blood, however strong it may be. Hence, lateral compression can be usefully applied only to such arteries as have beneath, and not too far distant, a solid support in the shape of bone.

Compression of arteries may be effected with *the fingers*, with *pads*, *tampons*, or *compresses*, with *tourniquets*, and with *Esmarch's apparatus* for bloodless operations.

DIGITAL COMPRESSION, in violent hemorrhages from recent wounds, is well adapted to stay the bleeding until ligatures can be applied. When a finger commands an artery, there is no danger as long as its command continues. Digital pressure may be applied immediately to the bleeding apertures in the vessels themselves, by inserting the fingers into wounds. In a considerable number of cases related in this article, compression employed in this way saved life, when, otherwise, it could not have been preserved. In many instances this proceeding can be executed by the patient himself.

But, digital compression may be laterally applied to arteries, with success, whenever they run near enough to bones for a fixed point of resistance to be afforded thereby. The following are the principal places where this use of pressure made with the fingers can be employed:—

For the *common carotid artery*, the fore-part of the side of the neck, between the larynx and the inner border of the sterno-mastoid muscle, is the place where that vessel can be compressed against the transverse processes of the vertebræ. To effect this, the thumb of the opposite hand (*e. g.*, that of the right hand for the left carotid, and vice versa) should be placed at the inner edge of the sterno-cleido-mastoid muscle, opposite the lower edge of the thyroid cartilage, and thrust backward, downward, and inward, so as to force the artery away from the vein and against the transverse processes of the cervical vertebræ; the fingers crossing the median line of the nape, but making no counter-pressure. The energy of the compressing force can be much increased by adding to it that of the other thumb. By many it is held that the common carotid artery may, with peculiar advantage, be compressed against the so-called tubercle of Chassaignac on the transverse process of the sixth cervical

vertebra, in a manner similar to that shown in the accompanying wood-cut (Fig. 346), the pressure being applied two or three inches above the upper border of the clavicle.

Fig. 346.

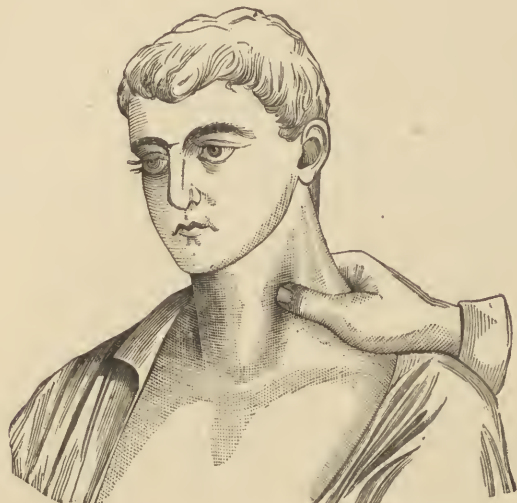
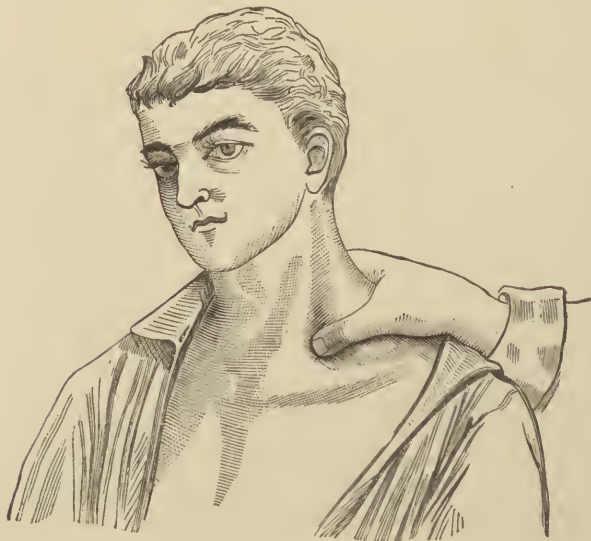
Digital compression of the carotid artery. (Esmarch.)¹

Fig. 347.



Digital compression of the subclavian artery. (Esmarch)

For the *subclavian artery*, the supra-clavicular fossa is the spot where the thumb should be applied in order to compress the artery against the first

¹ Permission to copy this wood-cut and many others that follow it, to which his name is attached, has been generously given to the writer by the distinguished Surgeon-General of the Prussian Army, for which courtesy it is but just to make this acknowledgment.

rib, after its issue from behind the *scalenus anticus*, and in the third part of its course. (Fig. 347.) By drawing the shoulder forward, and with it the clavicle, more room may be obtained for applying the pressure to the artery. This vessel is so deeply seated, however, that it is often wise to employ a substitute for the fingers to compress it against the first rib; and the best substitute is a common door-key, of good size, the handle of which should be covered with the turns of a narrow roller. It should be firmly pressed downward into the subclavian hollow of the neck, immediately above the clavicle. The tourniquet of Petit, when reversed, affords a thumb-piece, which, enveloped in a roller, may be used in the same way as a door-key.

Fig. 348.

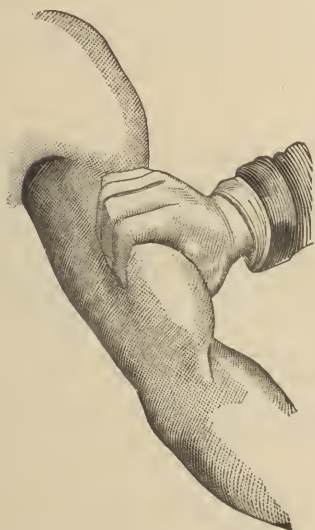
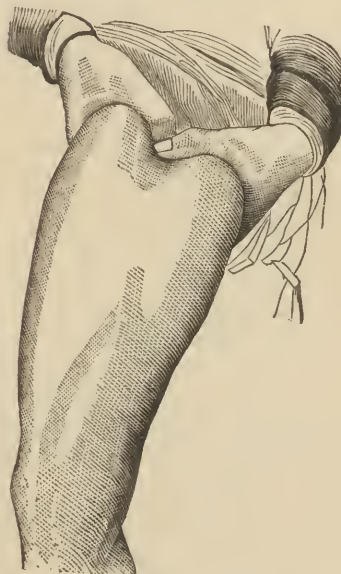


Fig. 349.



Digital compression of the brachial artery. (Esmarch.)

Digital compression of the femoral artery. (Esmarch.)

For the *axillary artery*, the anterior fold of the arm-pit marks the spot where, when the arm is raised, the artery can readily be compressed against the head of the humerus, with the fingers.

For the *brachial artery*, the centre of the upper arm is the place where, at the inner border of the biceps, this vessel can easily be compressed against the humerus. (Fig. 348.) The fingers should be placed over the artery, along the inner edge of the biceps muscle, with the thumb on the opposite side of the limb.

The *abdominal aorta*, when the walls of the belly are relaxed and the intestines empty, can be compressed against the spinal column on a level with the umbilicus. To effectually make digital compression of the abdominal aorta, the patient must be in a recumbent position, with the shoulders raised and the limbs drawn up, so as to relax the abdominal parietes; three fingers of one hand should be placed over the artery, somewhat to the left of the umbilicus, the thumb stretching toward the other flank; and the fingers of the other hand should be placed upon those of the first, in order to make the pressure strong enough to completely flatten the vessel. This pressure, however, cannot be borne for any considerable length of time, unless a narcotic or anæsthetic be administered.

The *common iliac artery* and the *external iliac* in the upper part may be

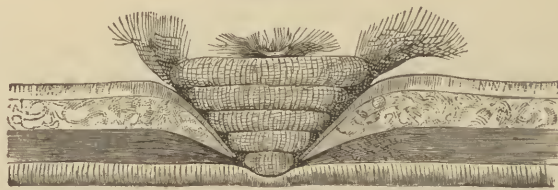
compressed in a similar way against the brim of the pelvis. But the latter can be compressed more readily and for a longer time against the upper border of the horizontal ramus of the pubis, just previous to its exit from the pelvis, above the middle of Poupart's ligament.

The *femoral artery* can easily be compressed against the ilio-pectineal eminence, just below Poupart's ligament. It is found in the middle of a line drawn from the anterior superior spinous process of the ilium to the symphysis pubis. When the current through this artery is to be restrained, the thumb may be placed upon the vessel at this spot, while the fingers grasp the outer part of the thigh; but when the pressure is to be applied lower down, both hands must be used, one thumb being placed upon the other, with the fingers embracing opposite sides of the limb (Fig. 349). In this way the femoral artery may be compressed against the femur as far down as the lower third of the thigh; but, low down, digital compression is difficult and uncertain, because of the thickness of the parts lying over the vessel, at least in fleshy subjects.

PADS, TAMPONS, OR COMPRESSES, are often applied to wounds with advantage for the suppression of surgical hemorrhages, until such time as ligatures can be applied. In case of their employment the pressure is exerted by means of a bandage. But before a compress is applied in this way, the injured part, if it be an extremity, must be carefully bandaged (with flannel if possible, for it is the best material for the purpose) from below upward until the whole limb is covered, in order to prevent the occurrence of diffuse infiltration of the connective tissue with blood, or sanguineous infiltration of the limb—a very dangerous complication. A firm pad, made if possible of antiseptic material, is then placed upon the wound, and firmly pressed upon it by a tightly-drawn bandage. This part of the proceeding is best accomplished with a bandage made from some elastic material; for instance, India-rubber or elastic braces.

But if a large artery is opened, it is safer to apply a *conical tampon* in the wound itself. For this purpose a square piece of antiseptic gauze, or of muslin soaked in carbolated oil, is pressed with a finger as deeply as possible into the wound, and then the cavity is filled, as the finger is withdrawn, first with small, then with larger antiseptic balls of prepared jute or wadding, until the last overlaps the margin of the wound. (Fig. 350.) The wads

Fig. 350.



Application of a conical tampon made of antiseptic balls. (Esmarch.)

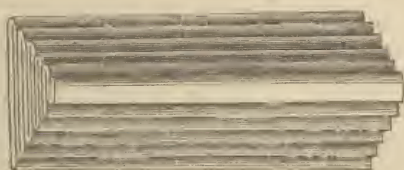
should be quickly and firmly put into place. The whole is kept in position by a tightly-drawn bandage; if possible, by an elastic one. On the arrival of the patient at the hospital, or at his home, the tampon must be removed; and if the hemorrhage return, or if the coats of the artery be perceptibly injured, a ligature must be applied to it, on each side of the wound, where its coats are sound.

Graduated compresses that are pyramidal, wedge-like, or elongated in shape, are not unfrequently applied also by means of tightly-drawn bandages to tem-

porarily restrain the flow of blood from recent wounds; but when they are not placed so as to press exactly on the bleeding orifice in the wounded vessel, they often do much harm. Especially is this the case when, from the faulty adjustment of such compresses, the wounded limb becomes widely infiltrated with extravasated blood.

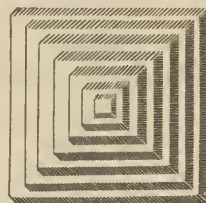
When after a few hours' delay, in cases where the compresses and bandages have been accurately applied, as directed above, we remove the dressings in order to tie the artery in the wound, we sometimes find that the aperture in the vessel has become closed by the contraction and retraction of its walls, aided by the formation of occluding coagula, and that the bleeding is permanently arrested. The procurement of the same result is often aided by a moderately-protracted syncope; and provided we keep the patient at rest, with a continuance of the same dressings to the wound, after carefully examining it, and abate all tendency to vascular excitement by giving cool acidulated drinks and an antiphlogistic regimen, we are sometimes gratified by finding that a permanent arrest of the hemorrhage has been secured.

Fig. 351.



Graduated compress (oblong). (Esmarch.)

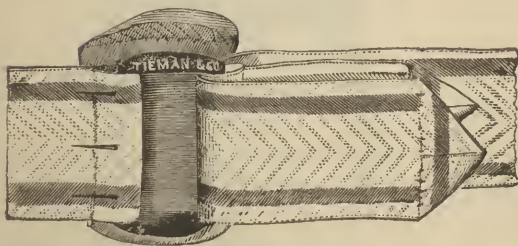
Fig. 352.



Pyramidal compress.

TOURNIQUETS.—Inasmuch as digital compression cannot be successfully continued, for any length of time, except by a skilled and powerful hand,

Fig. 353.



Field tourniquet.

Fig. 354.



Charrière's screw tourniquet

tourniquets have been invented by surgeons to supply its place. Many varieties of this instrument are in use. Among the best, as well as the most widely known of them, is that of J. L. Petit. (See Fig. 105, Vol. I. p. 572.) It consists of two brass plates, each set in a frame of brass bars in which rollers turn, a strong thumb-screw to force the plates asunder, a strong strap,

and a strong buckle. To apply this tourniquet properly, the limb should first be enveloped with a few turns of a roller, in order to protect the skin from pressure. A square pad, made by folding a roller three inches wide and two yards long, should be placed over the artery to serve as a compress. Upon this the base of the instrument should be laid, its two plates having already been approximated, and the strap should then be carried around the limb and securely buckled. By turning the thumb-screw the artery may be compressed at will.

The field tourniquet (Fig. 353) is composed of a strong linen strap, a strong buckle, and a pad; and is, in substance, the strap and buckle of a Petit's tourniquet, which are to be used without the frame and screw of that instrument.

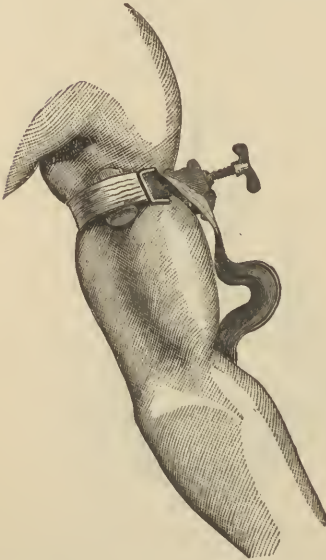
The tourniquet of Charrière (Fig. 354) is provided with a pad for making counter-pressure; but, in respect to efficiency, this instrument does not equal the tourniquet of Petit.

The well-known firm of Tiemann & Co., surgical instrument makers, have devised a useful tourniquet which bears their name (Fig. 355). In this instrument the pressure is applied to the artery by a pad which is projected by a screw. This tourniquet will not easily turn over, nor hinder the circulation of the venous blood.

But the constriction of the limb which attends the employment of all tourniquets which act by means of a strap passing around the limb, is liable



Fig. 356.



Compression of the brachial artery by a screw tourniquet. (Esmarch.) The tourniquet plate is displaced to show the application of the compress in the line of the artery; the plate is adjusted immediately over the compress before the strap is tightened.

Fig. 357.



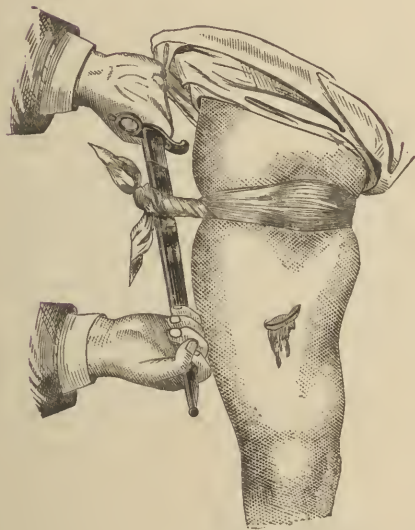
Compression of the femoral artery by a screw tourniquet. (Esmarch.) The plate of the instrument is adjusted over the compress before the strap is tightened.

to cause a great deal of pain, and this circumstance has led to the invention of many instruments which act only on the opposite sides of the limb. Among them must be mentioned the tourniquet or artery-compressor of Professor Gross. (See Fig. 110, Vol. I. p. 573.)

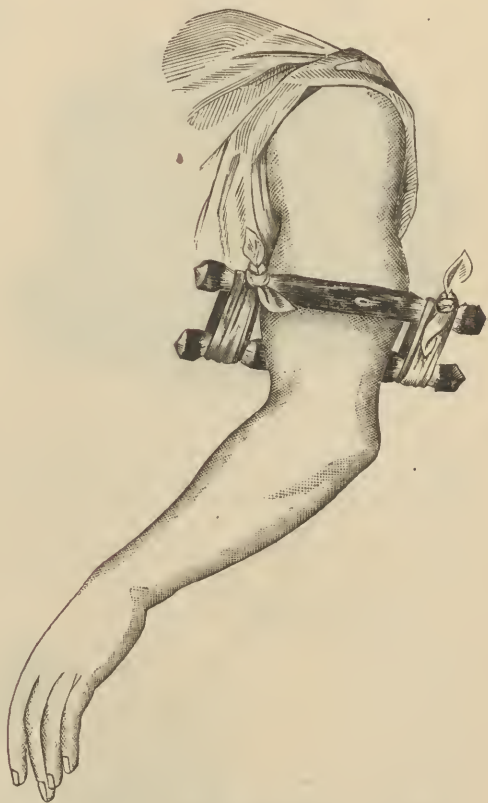
In default of the tourniquets already described, an effective instrument for compressing the main artery of the thigh, arm, etc., may be improvised in the following manner:—a pocket-handkerchief, or piece of muslin of corresponding size, folded into the form of a cravat and knotted in the middle, or containing a pebble placed at the same spot, for a compress, should be tied securely, but rather loosely, about the limb, and then twisted with a stick, a ramrod, or a bayonet, etc., inserted underneath. (Fig. 358.) I have several times known old soldiers to stop hemorrhage for comrades in this way.

Fig. 358.

Fig. 359.



Improvised torsion, or the old soldier's tourniquet
(Esmarch.)



Improvised double-stick tourniquet of Völkers.
(Esmarch.)

Comparatively little pressure, however, if exerted by means of a stick against the inner side of the arm, is sufficient to control the circulation in the brachial artery; the muscles may, in this way, be forcibly separated, partly forward, partly backward, and the artery pressed flat against the humerus. Völker's improvised stick tourniquet, which attains this object, may readily be prepared from two stiff shoots or branches of a tree, and two handkerchiefs. (Fig. 359.)

The blood-stream in the abdominal aorta can be most securely controlled, if the intestines have been previously emptied, by compressing the aorta

itself against the vertebræ, in the region of the umbilicus. For this purpose, Lister's or Pancoast's abdominal tourniquet (Figs. 111, 112, Vol. I. p. 574) should be employed. The pad is moved by a long screw, so as to act upon the aorta; the counter-pressure is furnished by the cushion for the back. The artery compressors of Skey and Erichsen may also be employed to control the circulation in the abdominal aorta.

ESMARCH'S APPARATUS.—Esmarch's apparatus for the bloodless operation affords a very simple, a very efficient, and a very safe means of arresting the circulation. If an elastic band of India-rubber, whether round or flat, be wound with strong traction several times round a limb, and the ends fastened by a knot or safety pin, all the soft parts, and with them the arteries and veins, may be so firmly compressed that not a drop of blood can pass through.

Fig. 360.

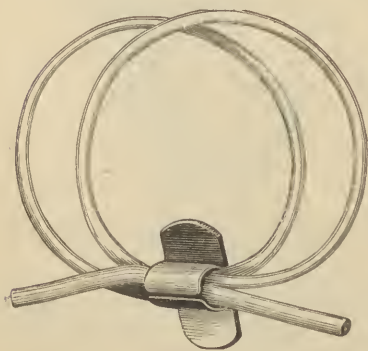


Esmarch's apparatus for elastic compression.

It is evident that the effects of an elastic band, when properly applied, must be continuous and lasting, while the strap of Petit's tourniquet soon stretches and thereby becomes inefficient. The elastic band also can be successfully applied in any position we may choose; and its employment does not require an intimate anatomical knowledge of the part which is subjected to compression. In urgent cases, an elastic brace may be used in its stead.

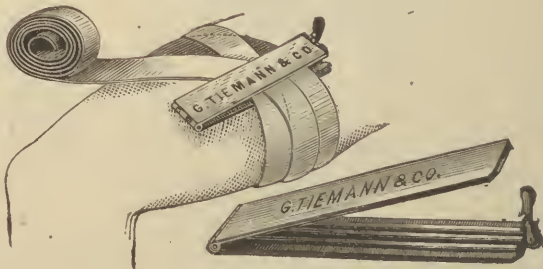
Esmarch's apparatus for performing operations on the extremities without loss of blood consists essentially of an elastic roller made of India-rubber, and an elastic tube or ligature, made also of India-rubber, with a chain and hook, or a ring, or a clamp, or a safety-pin for fastening the ends. In Fig. 360 an elastic roller is

Fig. 361.



The elastic tube or ligature fastened with a brass ring.

Fig. 362.

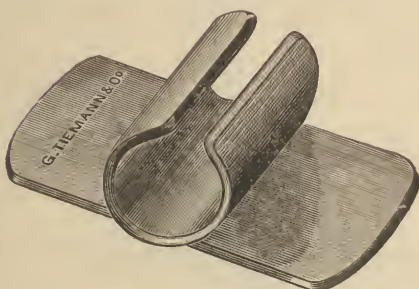


Langenbeck's clamp for fastening Esmarch's elastic roller.

represented, together with an elastic tube or ligature wound around its exterior, and fastened with a hook and chain. Figs. 361, 363 and 364 show the mode of securing the apparatus with a ring, and Fig. 362 the mode of

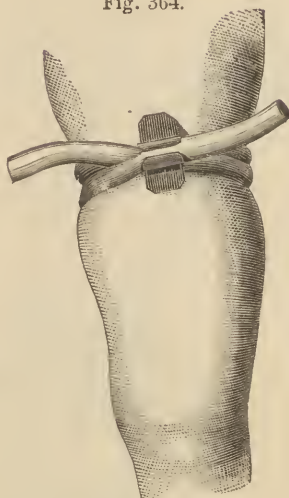
accomplishing the same end with a clamp. Figs. 366 and 367 show the application of Foulis's device for effecting the same purpose.

Fig. 363.



The open brass ring for fastening the elastic tube.

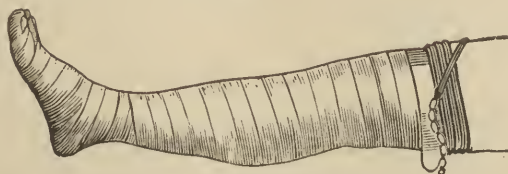
Fig. 364.



Elastic tube or ligature drawn tightly round the thigh, and fastened with a brass ring, compressing the femoral artery. (Esmarch.)

Although it is not strictly within the scope of this article, I will in a few words describe the process of rendering a limb bloodless by the method of Esmarch, for in this connection it will be of interest to all readers. The member having been covered with oiled silk or varnished paper to prevent soiling of the bandage, an *elastic roller* is firmly applied to it from the tips of the toes, or fingers, upward, until the site of the proposed operation has been passed; by this means the blood is driven completely out of the vessels. Where the roller ends, an elastic ligature, or tube of India-rubber, is wound with moderately strong traction several times around the limb, compressing the arteries so that no more blood can pass through them; and the ends are fastened together by a hook and chain, or by some other approved method.

Fig. 365.



Right foot and leg with the elastic roller and ligature in place.

Fig. 365 represents the right foot and leg with the elastic roller and the elastic tubing or ligature *in situ*. The elastic roller, together with the oiled silk,

Fig. 366.

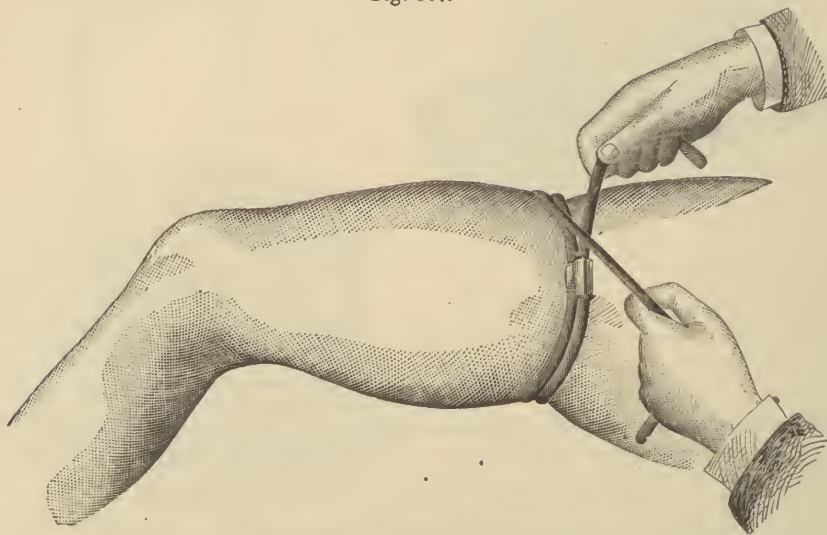


Foulis's fastening apparatus for the elastic ligature. (Esmarch.)

is next removed, but the elastic tubing or ligature is left on to act as a tourniquet, and, provided that the apparatus has been properly applied, the limb below this tourniquet exhibits a completely blanched appearance, like that of a corpse. Any operation can now be performed without loss of blood.

But parts of limbs which contain unhealthy pus, must not be firmly bandaged with the elastic roller, because infecting matter might thereby be driven upward into the connective tissue, and into the lymphatics. In such cases one must be satisfied with holding the limb in an elevated position for

Fig. 367.



Showing compression of the femoral artery with Esmarch's elastic ligature, and the application of Foulis's fastening clasp or ring. (Esmarch.)

a few minutes in order to make the blood run out of it, as practised many years ago at the New York Hospital by the American surgeons, Mott and Stevens, before applying the elastic tubing or ligature to control the circulation.

Nicaise's modification of the elastic roller and ligature is recommended on the high authority of Esmarch. It consists of a strong India-rubber belt, to one end of which are fastened a hook, and a number of rings one after the other. (Figs. 368 and 369.)

The application of Esmarch's tube to the axillary artery is shown in Fig. 370.

To arrest the circulation of blood in a finger, an India-rubber tube, about the size of a goose-quill, suffices; it should be wound around the finger two or more times, its ends crossed on the back of the hand, then carried around the wrist, and tied on its dorsum.

An elastic ligature of similar size, and constructed of the same material, when tightly drawn around the root of the penis and scrotum, will restrain the outflow of blood from the arteries of these parts. (Fig. 371.)

To compress the common femoral artery, the India-rubber tube is wound once or twice around the thigh just below the groin, and its ends are crossed over the groin, carried around the posterior aspect of the pelvis, and finally hooked together over the hypogastric region. (Fig. 372.)

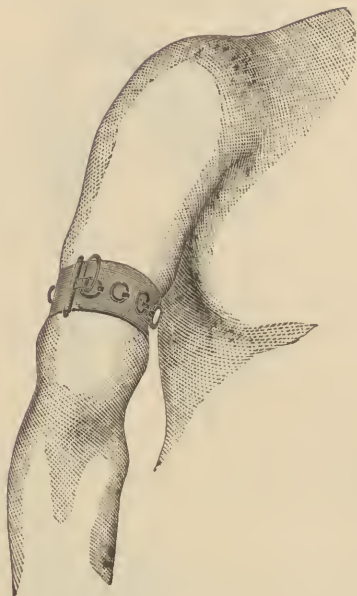
A pad consisting of a firmly rolled linen bandage may be placed as a compress over the external iliac artery, immediately above Poupart's ligament,

Fig. 368.



Nicalse's elastic belt for compressing the arteries of the extremities, and thus restraining traumatic hemorrhage. (Esmarch.)

Fig. 369.



Nicalse's elastic belt applied to the arm for compressing the brachial artery. (Esmarch.)

and may then be energetically pressed down upon that vessel by several figure-of-eight turns of a strong India-rubber roller bandage. (Fig. 373.)

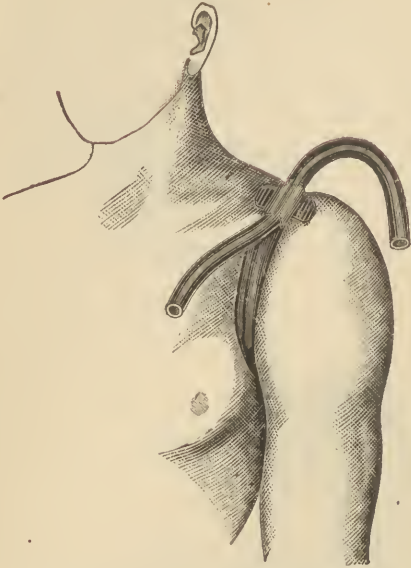
Should there be no abdominal tourniquet at hand, a pad may be improvised in the following manner:—A strong linen bandage about eight yards long and four inches broad, is wound around the middle of a stick about a foot long, and having the thickness of a thumb. This pad is placed just below the umbilicus, and is kept in position by an assistant. It should then be pressed with considerable force against the spinal column by many turns of an elastic bandage, four inches in width, each of which is wound around the body at the loins. (Fig. 374.)

But if circular compression of the abdomen be undesirable, the linen bandage should be wound around the middle of a stick long enough to have its ends embraced by the turns of an elastic bandage, which is passed underneath the operating table. (Brandis's method, Fig. 375.)

Whenever necessary, one or even both extremities may be kept bloodless for several hours without injury.

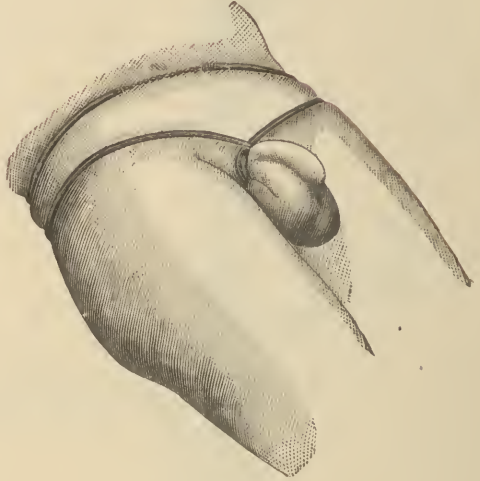
At the conclusion of an operation in which the elastic ligature has been employed, the ligature itself must *not be slowly* loosened, but be *quickly* taken off from the limb. The consecutive hemorrhage is generally considerable, because the walls of the bloodvessels are temporarily paralyzed. The hemorrhage must, therefore, be provided against, before removing the elastic ligature, either

Fig. 370.



Elastic compression of the axillary and other arteries at the shoulder. (Esmarch.)

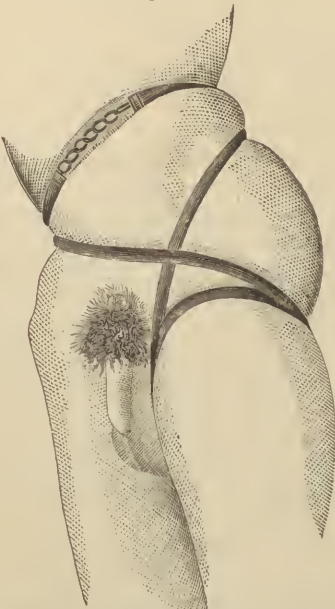
Fig. 371.



Elastic ligature applied to the penis and scrotum, for the purpose of restraining surgical hemorrhage therefrom. (Esmarch.)

by tying the divided vessels (as in amputations, excisions, and in most open wounds), or by applying a tampon to the wound (as in necrosis cases, etc.).

Fig. 372.



Elastic compression of the common femoral artery. (Esmarch.)

Fig. 373.



Elastic compression of the external iliac artery. (Esmarch.)

The parenchymatous bleeding which follows in spite of these measures is easily arrested by affusing the surface of the wound with carbolized iced

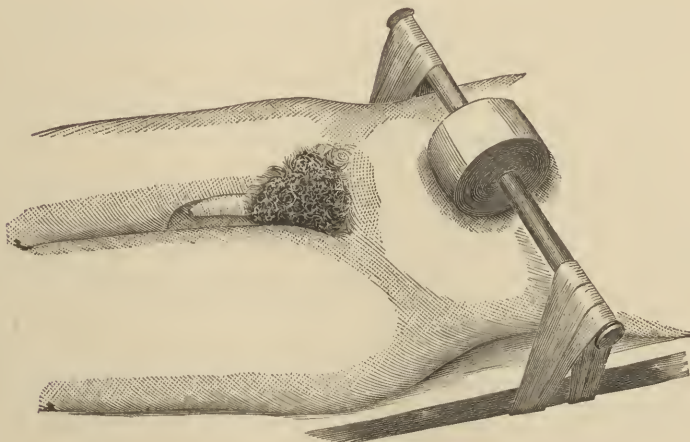
Fig. 374.



Improvised compression of the aorta, with a pad and an elastic roller. (Esmarch.)

water, or by applying the induced current to the same, or by compressing the main artery with the fingers, above the wound. (See also Vol. I., page 575.) If small arteries spurt, they must be tied or twisted.

Fig. 375.



Compression of the abdominal aorta by Brandis's method. (Esmarch.)

The elastic tourniquet of Esmarch, many ways of applying which have been given above, with illustrative figures, is in some respects superior to all other tourniquets, because it can be applied around any part of the limb, and because the location or course of the main arteries need not be considered while putting it on.

III. LIGATION.

The only truly efficacious means of arresting the hemorrhage from wounds involving large arteries, are compression and ligation, as Boyer in substance justly remarks. And the direct or immediate application of a ligature to a wounded vessel is by far the most satisfactory way to stop its bleeding. It affords a feeling of security which is yielded by no other plan of treatment, and enables the surgeon to leave his patient, at whatever distance, feeling, if the artery be sound where it is tied, that there is absolutely no risk of hemorrhage left behind. Acquaintance with the ligature as a hæmostatic

agent has come down to us from the most ancient times; but when and where it was first employed is now entirely unknown. It was, however, well known to Celsus in the first century after Christ; to Galen about the close of the second century; to Aëtius in the fifth, to Paulus Ægineta in the seventh, and to Rhazes in the tenth century. Moreover, Rhazes recommended the employment of two ligatures in order to suppress traumatic hemorrhage, of which one should be put round the artery on each side of the aperture, because blood might issue from the inferior portion of the artery, that is, regurgitant or distal hemorrhage might occur, if the distal portion of the artery were not also tied. Rhazes recommended the complete severance of the wounded vessel, so that its cut extremities might retract. Avicenna in the eleventh, Albucasis in the twelfth, and Averrhoes in the thirteenth century were well acquainted with ligation as a hæmostatic measure. The early modern writers on surgery mention all the ancient methods of arresting hemorrhage. Guy of Chauliac recommended the ligature on the authority of Galen and Avicenna. It was also recommended by Brunus, Theodoricus, Rolandus, and Lanfrancus. Thus it appears clear that the use of ligatures for arresting surgical hemorrhages was well known to the ancient surgeons, and was never forgotten, even in the darkest ages.

Nevertheless, the glory of introducing the ligature as a hæmostatic agent in *amputations* is unquestionably due to Ambroise Paré. In 1564 he published an account of his discovery, which, he says substantially, he was enabled to make by the special favor of the sacred Deity. But so slowly did the ligature make its way into general favor, that Sharpe, one of the surgeons to Guy's Hospital, writing in 1761, two centuries after its introduction into the great operations of surgery by Paré, found it necessary, in his well-known work, entitled "A Critical Enquiry into the Present State of Surgery," formally to advocate its employment for the arrest of hemorrhage from wounded arteries, in preference to styptics or the cautery, on the ground that "it was not as yet universally practised amongst surgeons residing in the more distant counties" of England. But why did it take two centuries to diffuse everywhere the employment of the simplest and the best surgical means which we possess for suppressing surgical hemorrhages? The reason simply was that surgeons in general were quite ignorant of the natural process of hæmostasis, and, consequently, knew not how the ligatures should be applied, nor of what form and material they should be made. Indeed, it was not until Dr. Jones, by appealing to experiment, and by a series of admirably-conducted investigations, showed that the division of the internal and middle coats of the artery, while tightening the noose, the very thing that surgeons then were most anxious to avoid, was the point on which the patient's safety actually depended, and pointed out the form and size of ligature that was most safe, the amount of traction which should be used in tying it, and the processes employed by nature for making the occlusion of the vessel permanent; it was not until all this was done by Dr. Jones, that surgeons in general acquired full confidence in the ligation of bloodvessels as, *par excellence*, the hæmostatic measure.

Avicenna recommended the employment of a "flaxen thread" for the ligation of wounded arteries. In our day, the materials chiefly used for making ligatures are silk, hemp, flax, silver, lead, iron, and the tissues of animals. Those of uncolored silk, soaked for half an hour in carbolized wax in a melted state, are preferred by many surgeons. There are two kinds of silken thread which answer best, the saddler's and the dentist's. But, whatever the material may be, the ligature should be round in shape, and should correspond in size to the artery to be tied. For small vessels it need not be larger than ordinary sewing-silk, and this size is large enough for the radial,

ulnar, anterior temporal, facial, etc. For the femoral, iliac, axillary, subclavian, or carotid arteries, saddler's silk is sufficiently stout to supply the ligature; and for the largest arteries, saddler's silk, when doubled, affords a ligature of sufficient size and strength. Ligatures should be cut from nine to twelve inches in length. They should also be well waxed, for thus their limpness is overcome, their knots hold better, and they prove less irritating from the coating of an animal substance which they have received; the best ligatures, however, consist of carbolized strings of animal origin, as for instance, catgut, kangaroo sinews, whale-tendons, etc.

Arteries that are wounded must always, if possible, be secured by ligatures at the very place where they are wounded. For this purpose the wound in the exterior parts must be sufficiently enlarged under the guidance of the fingers, and the blood-clots thoroughly cleared out with the fingers or with a carbolized sponge. And, while the exterior parts are held asunder with retractors, the surgeon must, carefully prepared and guided by a good knowledge of anatomy, proceed toward the bottom of the wound until the injured artery is found. He then must separate it from its cellular sheath, carefully ligate it above and below the injured spot with carbolized catgut, and divide it between the two ligatures, so that both ends of the divided vessel may be able to retract.

If, notwithstanding this double ligation, blood still wells up from the bottom, some other vessel must be injured. Such bleeding often results from the injury of a branch which is given off from the posterior wall of the main artery at the wounded spot. To ascertain this condition of things, the injured piece of artery between the two ligatures may be cut out. Or the bleeding may proceed from some other branch which is injured in the further course of the wound. In either case, the vessel must be sought for, and an attempt to close it with a ligature must be diligently made.

If, besides the artery, a large vein be wounded, this is made known by the fact that, in spite of the ligation of the artery, dark blood in large quantity flows from the wound, especially if pressure be made at a higher point. Such venous hemorrhage may generally be arrested by a light compress or by the tampon; but if not, the injured vein must also be tied in the wound.

These operations are often difficult; they can, however, be made easier by employing Esmarch's apparatus for elastic compression. (Fig. 360.) But, to drive out all the blood from the limb is not recommended, because one cannot then easily recognize the empty veins, nor avoid injuring them. It is therefore sufficient to apply the elastic bandage above and below the wound in such cases. The circulation is thereby entirely arrested, while the veins remain full, and can always be quickly refilled by a momentary loosening of the lower or distal bandage, should the blood escape from them in the course of the operation.

Moreover, in performing this operation, on which the life or death of the patient depends, no dread ought to be entertained of enlarging a small stab or a shot-hole into a very wide and deep wound, when necessary to lay bare and tie the bleeding vessel.

If this operation of tying the injured artery in the wound, which is called direct ligation, be impracticable, on account of the depth or the relations of the injured artery, or because the wound is closed, and it is not desirable to open it again, as, for instance, after amputation or excision, the trunk of the bleeding artery must be ligated at the nearest convenient spot, on the plan of Anel's operation.

After the hemorrhage has been suppressed, antiseptic dressings must be applied, and drainage tubes should also be inserted whenever suppuration is likely to occur.

INSTRUMENTS REQUIRED FOR THE LIGATION OF ARTERIES.—Much ingenuity has been exhibited in devising instruments for operating on wounded blood-vessels. Hence the surgeon is well equipped with those which are needed for tying the deep as well as the superficial arteries; also for securing them in particular regions, and in their continuity as well as in open wounds.

When ligatures have to be applied to arteries in open wounds, as, for instance, after amputations, the mouth of each artery must be seized and drawn out from the tissues in which it is buried. For this purpose the tenaculum invented by Bromfield, surgeon to St. George's Hospital (Fig. 134 Vol. I. p. 581), is much used in America, and in many cases does extremely well. Some care, however, should be exercised in using it; for, it is liable to pierce other structures along with the artery, an accident which, in general, should be avoided; and, inasmuch as it seizes an artery by perforating its walls, it has several times happened after its employment that dangerous, and, in one case at least, observed by Erichsen, fatal hemorrhage occurred from ulceration of the artery where it had been accidentally punctured by the instrument above the part around which the ligature was applied.

But the forceps in common use are, upon the whole, to be preferred as instruments for seizing and drawing out the ends of divided arteries, in order that ligatures may be put around them, in open wounds. There are several varieties of artery forceps, some having rat-toothed and others serrated points, some having narrow and others broad blades, while still others are fenestrated, each of which modifications offers peculiar advantages. For ordinary vessels, such as demand the ligature in common operations, an instrument like that represented in figure 376, is preferable. Its blades are long and slender, and fastened when closed with a spring-catch, while its points are fine and rat-toothed.

Fig. 376.



Spring-catch artery forceps.

One of the simplest and best instruments for drawing out and holding the main artery of a limb to be tied in an open wound, is Langenbeck's artery forceps. (Fig. 377.) Its points are serrated, and its blades can be fastened together by a button-slide. Moreover, the convexity of the instrument when closed facilitates the application of a ligature.

Fig. 377.



Langenbeck's artery forceps.

Another very useful instrument for the same purpose is Professor Hamilton's modification of Liston's artery forceps. (Fig. 378.) A serrated surface is placed behind the teeth at the end of the blades, by which their hold upon the artery is made more secure. With this instrument the surgeon can tie

an artery without an assistant, as it will retain its hold, and by its weight will draw the vessel out while the ligature is being applied.

Fig. 378.



Prof. Hamilton's spring-catch fenestrated artery forceps.

Among the best of the fenestrated instruments must be reckoned Dr. David Prince's tenaculum forceps. (Fig. 379.) As its name denotes, the extremity of one of the blades is armed with a long slender tooth capable of piercing the walls of an artery like a tenaculum. The blades themselves are held securely fastened together when closed by pushing a tube down over them. With this instrument also the surgeon can readily take up an artery without an assistant.

Fig. 379.



Dr. David Prince's tenaculum forceps

For the purpose of separating or detaching the sheath from the artery when about to tie it in a wound, and for many other objects, the plain forceps (Fig. 143, Vol. I. p. 584), can be advantageously employed.

For ligating deep-seated arteries, Professor H. J. Bigelow has devised a good as well as an ingenious instrument. When the artery has been seized, the operator closes the forceps, and by slightly moving the button forward, he locks the jaws. The ligature is then passed around the blades and partially tied. (Fig. 380.) By pressing forward the button the small hook will now expel the loop of the ligature from the blades on to the artery, whereupon the second knot is tied and the forceps removed.

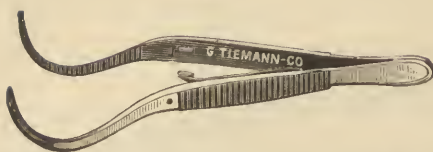
Fig. 380.



Professor Bigelow's forceps for tying deep-seated arteries.

For taking hold of meningeal arteries when required during resection of the cranial bones, etc., Professor J. S. Wight, of the Long Island College Hospital, Brooklyn, has invented a good form of forceps. (Fig. 381.) The instrument is four inches and three-quarters long. The jaws are curved, about an inch and a half long, and perforated near the ends, so as to introduce a ligature for arteries or tumors. It is fastened when closed by a spring catch.

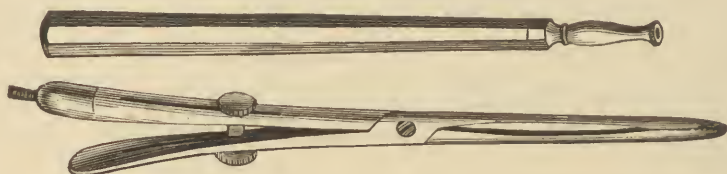
Fig. 381.



Professor Wight's meningeal artery forceps.

Intimately connected with the subject of the ligation of vessels are such instruments as the artery compressor, invented by Professor Gross. (Fig. 382.) It is designed to control the bleeding from vessels too deeply placed to be reached by the ligature.

Fig. 382.



Professor Gross's artery compressor.

The artery and needle forceps of Professor Wight (Fig. 383) has also been successfully employed to produce hæmostasis in cases where deeply-placed vessels were wounded.

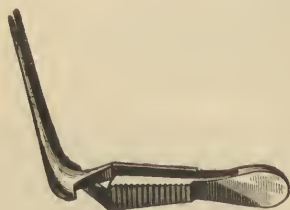
Fig. 383.



Professor Wight's artery and needle forceps.

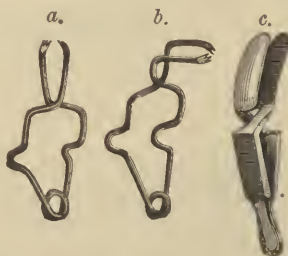
Such instruments as small spring forceps (Fig. 384) and serres-fines (Fig. 385) are often valuable to the surgeon when it is desirable to complete an operation before applying the ligatures.

Fig. 384



Milne's artery compression forceps.

Fig. 385.

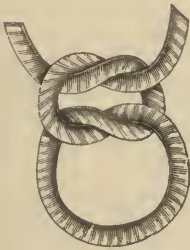


a. Straight serres-fine. b. Angular serres-fine. c. Langenbeck's serres-fine (known also as Nunneley's clip).

MODE OF LIGATING A DIVIDED ARTERY.—In order to ligate a wounded artery, after exposing its open mouth to view, it must be seized with suitable forceps, or a tenaculum, and drawn out a little from its bed, where it must be steadily held by the surgeon, while, with plain artery forceps in the other hand, he carefully separates or detaches from it all the contiguous structures, but especially the accompanying nerves. The ligature must then be passed around the upper or proximal end of the wounded artery. No nerve must be included in the loop, for the ligation of a nerve causes always intense suffering, frequently muscular spasms in the injured limb—sometimes death from tetanus. Many examples illustrating and corroborating this statement—like that of Lord Nelson, whose sufferings were very great for four months after his arm was amputated, because a nerve had been included in the ligature put around the brachial artery—have been placed on record. The ligature must be drawn with just enough force to divide the inner and middle coats of the artery, the giving way of which the surgeon often distinctly feels. Next, a ligature must be applied to the lower or distal end of the wounded artery also, in an equally careful manner. Moreover, in applying both ligatures care must be taken not to draw the artery too far out of its sheath, because the destruction of the vasa vasorum consequent thereon might lead to sloughing of the artery-walls and secondary hemorrhage.

The ligature, having been drawn sufficiently tight, should then be secured or fastened with a reef-knot (Fig. 386), and without any pulling or dragging

Fig. 386.



The "reef" or square knot.

Fig. 387.



The "granny."

Fig. 388.



The surgeon's knot.

of the artery itself. The "granny" (Fig. 387) must not be used, because it easily becomes loose. The surgeon's knot (Fig. 388), also, must not be employed in tying arteries, because it may fail to close the lumen of the vessel.¹

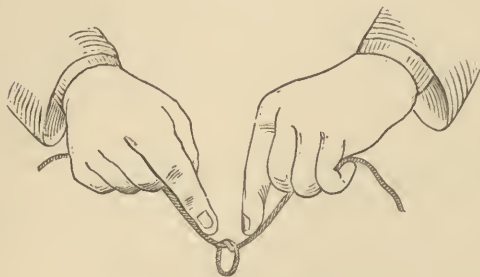
Boyer remarks that the surgeon's knot has the inconvenience of being tightened with difficulty, while at the same time it fails to entirely close the artery, even though great force be employed in tightening it; and that its disadvantage is proved by the following case: Chopart operated on a gardener for popliteal aneurism in presence of the most distinguished professors of the Ancient School of Surgery, by the old method. The ligatures being placed, and the first being tightened by the surgeon's knot, the compression was withdrawn, but, notwithstanding, the blood escaped abundantly. A second and a third ligature were placed and tightened in the same manner, and with as small success. The failure, after a moment's deliberation, was attributed to the ossification of the artery, or to some unknown cause, and it was decided to amputate. On examining the limb, however, the artery was found in a natural state; it was embraced by the three ligatures; but, although these ligatures had been tightened in the most for-

¹ These cuts are the same as Figs. 138, 139, and 140, in Vol. I. p. 582; they are reproduced here as a matter of convenience.

cible manner, neither of them had perfectly effaced the lumen of the vessel, but so incompletely that a large stylet could easily penetrate it. This fact is sufficient to prescribe the surgeon's knot forever in operations for hemorrhage, as well as in those for aneurism. I have, myself, often observed that ligatures tied with the surgeon's knot do not completely close arteries in the cadaver.

The tightening of the knot (which, as stated above, must always be a reef or square knot, and never a "granny" or a surgeon's knot, at least when tying bloodvessels) should be

Fig. 389.



Showing how to draw the knot.

done with the tips of the index-fingers or the thumbs, placed near the knot itself (Fig. 389); taking care, also, that the thread is placed above the point where the forceps grasps or the tenaculum pierces the vessel to be tied.

When the tightening of the knot is finished, one end of the ligature, if it be of carbolized silk or similar material, should be cut off near the knot, and the other should be brought out of the wound. Every ligature should

be carefully treated in the same manner, except in amputations, where it is customary to bring out both ends of the ligature pertaining to the main artery and knot them together, in order to distinguish this ligature from the others. The wound itself is then freed from all coagula, and carefully cleansed by washing or sponging with carbolized water or some other antiseptic liquid, the edges approximated and carefully secured in apposition by interrupted sutures and strips of adhesive plaster, an antiseptic dressing being placed over all. Thus the last step in the operation of *immediate* ligation of a wounded artery is completed.

Among our predecessors, the operation of *mediate* ligation, by which the tissues surrounding the artery were also included in the ligature, and thus the artery was compressed by the ligature through the medium of those tissues, was in vogue. In our own day, good surgeons still advise that diseased vessels—for instance, those that are calcified and have very brittle walls—should have a cushion of soft parts tied about them to the end that the ligature shall not separate too soon, or prior to the permanent occlusion of the canal by adhesive inflammation. Professor Agnew says that he has often adopted this plan with gratifying success. But in mediate, as well as in immediate, ligation of arteries, the accompanying nerves should be excluded from the ligature. Manec's plan of placing a piece of bougie in the tube of the artery before tying it, as well as the elder Cline's plan of using a flat ligature and interposing a piece of cork between it and the artery, and Scarpa's substitution of a piece of linen for the cork, are, however, of very doubtful value. The advantages of all similar contrivances are, too, exceedingly doubtful, for Agnew declares that he cannot recall an instance of secondary hemorrhage in such a condition of the arteries, where the ordinary ligature has been employed, and that he thinks the danger over-estimated. My own experience and views are in full accord with this statement.

When the carbolized silk ligature is applied to an artery, its inner and middle coats are, in general, divided with more or less regularity, and the outer coat is so constricted as to completely arrest the flow of blood in the vessel at the place of ligation. (Fig. 390.)

A soldier, aged 27,¹ was wounded June 21, 1863, by a carbine-ball, which entered the left forearm two inches above the wrist, passed upward nearly to the elbow, and lodged. He was sent to Washington with the missile unextracted, and his arm much swollen. On the 29th an unsuccessful search was made for the ball. Sinuses extended along the radius, which was extensively denuded of periosteum. The patient was gradually failing. On July 3, the position of the ball having been found, it was cut down upon and removed. But, meanwhile, hemorrhage from the orifice of entrance commenced, and a tourniquet was applied to the brachial artery; it was loosened after the operation, without return of the bleeding. On the 5th, hemorrhage recurred, and compression of the radial and ulnar arteries by means of bandages was employed. On the 9th, "secondary hemorrhages being frequent, there was nothing left but amputation," which was accordingly performed just above the elbow. The patient's pulse came up after the operation; but anæmic exhaustion finally prevailed, and on the 11th he died. The brachial artery taken from the stump is shown in the accompanying woodcut (Fig. 390).

Fig. 390.



Showing a thrombus in the left brachial artery two days after amputation. (Spec. 1386, A. M. M.)

Fig. 391.

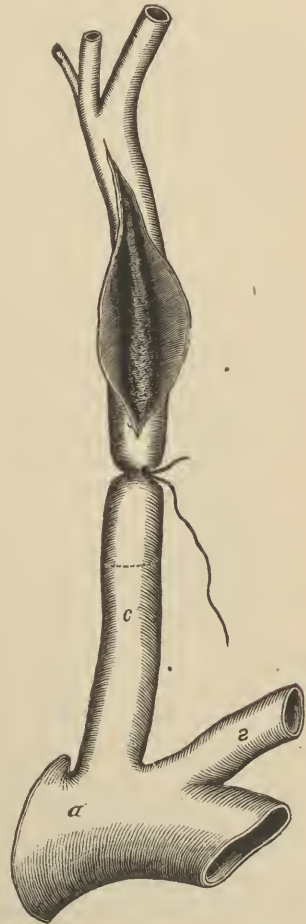


Showing the occluding coagula six days after ligation of the left subclavian artery. (Spec. 4089, Sect. I. A. M. M.)

But, when arteries are ligated in their continuity with silken threads, coagula should form in their tubes on the distal, as well as on the proximal, side of the ligatures. (Fig. 391.) In such cases the proximal is usually much larger than the distal clot.

A soldier, aged 35,² received, May 20, 1864, a gunshot wound, extending under the spine of the left scapula, forward and inward, toward the cavity of the chest. Gangrene attacked the wound, and extended deeply; secondary hemorrhage from branches of the left axillary artery occurred. On June 18, the left subclavian artery was tied in the outer third. On the 20th there were chills, followed by all the symptoms of pyæmia. On the 24th the patient died. Bromine had been applied to the gangrenous parts. The accompa-

Fig. 392.



Showing the coagulum in the distal part of left carotid six days after ligation; the distal much larger than the proximal coagulum. (Spec. 3179, Sect. I. A. M. M.)

¹ Med. and Surg. Hist. of the War of the Rebellion, Second Surg. Vol., p. 472.

² Ibid., First Surg. Vol., p. 540.

nying woodcut (Fig. 391) represents a wet preparation of a section of the ligated artery. The clots, both cardial and distal, are well shown.

The cardial or proximal is much larger than the distal coagulum in this specimen or preparation.

Sometimes, however, when arteries are tied in their continuity, a distal coagulum forms which is much larger than the proximal one (Fig. 392), as happened in the following instance:—

A soldier, aged 18,¹ received a gunshot fracture of the left zygoma and the left mastoid process, August 21, 1864. He was taken to the First Division Hospital, Fifth Corps, and on the 24th was transferred to the Lincoln Hospital at Washington. The wound extended from a point half an inch behind the outer canthus of the left eye to a point just behind the left mastoid process. Cold-water dressings were applied. On the 26th arterial hemorrhage occurred, which was checked by filling the wound with lint soaked in a solution of the persulphate of iron. It, however, recurred on the next day, and the left common carotid artery was ligated, under ether, above the omo-hyoid, an inch and a half below the bifurcation. Anodynes and stimulants were administered, but the patient sank under the repeated and copious hemorrhages, and died on September 2, six days after the ligation. At the *autopsy*, the meatus auditorius was found to have been cut across. It was impossible to detect from what vessels the hemorrhage had proceeded. Both lungs were anæmic. The specimen was sent to the Army Medical Museum. It is represented in the accompanying woodcut (Fig. 392). The vessels appear of the natural size, shrunk in alcohol. The letter *a* is placed on a portion of the aortic arch, the letter *s* on the left subclavian artery, near its origin, and the letter *c* on the trunk of the left common carotid. The ligature is represented *in situ*. The distal portion of the artery has been opened so as to show a firm fibrinous coagulum extending from the ligature to the bifurcation. The proximal coagulum is much shorter, occupying less than half an inch, the limit of its cardial end being indicated by a dotted line crossing the artery. The distal coagulum is more than thrice as long as the proximal.

The remarkable size which the distal coagulum attained in the case just presented, was, in all probability, due to the great freedom with which the blood flowed back or regurgitated into the internal carotid from its fellow of the opposite side and from the vertebral arteries, through the circle of Willis, when the common trunk was closed by ligation. Indeed, in no other part of the body is the communication between the terminal arteries nearly so free as it is between the internal carotids and the vertebrals at the base of the brain through the operation of this anastomosis.

REPAIR OF ARTERIES AFTER LIGATION.—The permanent occlusion of an artery which has been tied in its continuity with a carbolized silk ligature, or with a ligature made of flax, hemp, iron, or silver, is effected in the following manner:—1. The coagula, both proximal and distal, shrink, become permeated with leucocytes, decolorized, hardened, and finally organized. 2. The inner and middle coats take on adhesive inflammation at the place where they are cut in two by the pressure of the ligature; that is, plastic lymph exudes from their cut edges, which heals their wound, and eventually unites them and the corresponding coagulum into a homogeneous mass. 3. The external coat also takes on adhesive inflammation, and organizable lymph exudes, whereby this coat is strengthened and consolidated. This inflammation is caused partly by the dissection required to expose the vessel, and partly by the pressure and irritation of the ligature. Plastic lymph is effused between the vessel and its sheath, cementing them together, and often inclosing the noose and knot within an ovoid mass. Progressively with the exudation of lymph and the formation of a fibrinous ring or band around the

¹ Med. and Surg. Hist. of the War of the Rebellion, First Surg. Vol., p. 314.

external coat where it is constricted by the ligature, which re-enforces and materially strengthens it, the part of the external coat that has been crushed in the embrace of the ligature disappears by ulceration, and the ligature itself separates, as it is termed, so that by gentle traction it may be withdrawn from the wound. The ligature having come away, the two ends of the artery which has thus been severed by it readily coalesce, and become cemented together with plastic material. (Fig. 393.)

A corporal, aged 28,¹ was wounded in the face, Oct. 27, 1864, and on the 31st, was admitted to general hospital. A ball had entered the left side of the chin, passed inward, and lodged beneath the angle of the lower jaw, whence it was extracted through the mouth. Cold-water dressings and a compress to the jaw were applied. On Nov. 4, secondary hemorrhage occurred. It was arrested by plugging the wound with sponges. On the 6th the hemorrhage recurred, and the common carotid was tied just above the omo-hyoid; but, on the 16th, the patient died from exhaustion. The *autopsy* revealed a firm clot in the artery. The specimen was sent to the Army Medical Museum and is represented in the accompanying woodcut. (Fig. 393.) The proximal portion of the artery has been opened, so as to show the extent of the proximal clot.

The cause of death appears to have been anæmic exhaustion due to the losses of blood which had occurred prior to the operation.

The next example serves, likewise, to illustrate the process by which arteries become closed after they have had any of the so-called permanent ligatures applied to them:—

A soldier was wounded² on May 31, 1862, by a musket-ball, which entered the left mastoid process, passed beneath the maxillary, and emerged below the left eye. Secondary hemorrhage occurred on June 13 and 14; whereupon the left common carotid was tied above the omo-hyoid muscle; but death supervened on the 24th. The specimen was sent to the Army Medical Museum, and is represented in the accompanying wood-cut. (Fig. 394.) It consists of the proximal portion of the ligated artery, unconnected with the distal end, and has been laid open by incision so as to show a white fibrinous coagulum *in situ*. Apparently, the two ends had not yet grown together after separation of the ligature.

In each of the two examples just presented the ligature came away in less than ten days. But the time required for the disengagement of a silk, or flax, or hempen thread will vary in almost every case, according to the size of the vessel and the amount and kind of the extraneous tissues embraced in the noose, from three days to three weeks. The removal of ligatures may be hastened by gently pulling upon the ends which project from the wound. All that remain after eight or nine days should be treated in this manner at every dressing of the wound.

The principal drawback to the use of the kinds of thread mentioned above for ligatures, and, indeed, to the employment of all permanent ligatures, is the fact that they must

Fig. 393.



Showing the common carotid artery permanently occluded, and the coalescence of its ends after separation of the ligature, ten days after ligation. (Spec. 3409. Sect. I. A. M. M.)

Fig. 394.



Showing the proximal end of the left common carotid artery after separation of the ligature, ten days after ligation. Externally, the end appears irregularly rounded, and its mouth is closed by the process of healing. Internally, it is completely plugged by a white fibrinous clot. (Spec. 508. Sect. I. A. M. M.)

¹ Med. and Surg. Hist. War of the Rebellion, First Surg. Vol., p. 393.

² Ibid., p. 396; also, Catalogue of Army Med. Museum, p. 460.

make their way through the vessels they embrace by an ulcerative process. For, in connection with this process under such circumstances, there are two sources of danger:—1. The walls of the artery may be extensively opened by sloughing, and thus the hemorrhage may recur. 2. The ulceration through the artery may take place before the clots in its tube are properly strengthened and fastened by the healing process, and thus, too, a failure of the operation may be wrought. The risk of sloughing, however, arises mainly from isolating the artery too much, or from separating it too extensively from its sheath, while dissecting to expose it or while preparing to pass a thread around it, whereby the minute vessels which nourish its coats are too extensively destroyed; hence the dangerousness of passing a spatula or the handle of a scalpel under the artery, and of dragging it out of its bed when tying it. The premature ulceration of a ligated artery is generally due to constitutional causes. It is, however, my belief that the risk of the occurrence of secondary hemorrhage after permanent ligations, when *properly performed*, is much exaggerated in many of the current statements. Still, the ulcerative process by which all permanent ligatures, no matter how skilfully applied, must make their way out, is unquestionably attended with more or less danger according to the case; and to avoid whatever there may be of this danger, threads made of animal tissues are now extensively employed for tying bloodvessels, in the hope that, after producing complete and permanent hæmostasis, they will themselves disappear by absorption, and that thus, while acting as temporary ligatures, they will give permanently good results.

ANIMAL LIGATURES.—The use of animal ligatures was first suggested in 1814, by Dr. Physick, of Philadelphia. Dr. D. M. Reese, the American editor of Cooper's Surgical Dictionary, which was republished in New York, in 1842, says: "To our distinguished countryman, Professor Physick, of the University of Pennsylvania, is undoubtedly due the honor of having first introduced what is known as the animal-ligature into surgical practice. His ligatures are made of chamois leather, and he and the late Dr. Dorsey usually rolled their ligatures on a slab to make them round and hard. The advantages proposed by the ligatures of Dr. Physick are, that, being made of animal matter, the knot or noose, which is all that is left in the wound, will serve long enough to obliterate the artery, and be speedily removed by the absorbents, thus avoiding the difficulty arising from a foreign body, however minute. These ligatures have been used in this country to a great extent, and Sir Astley Cooper has demonstrated their superiority in his own operations. Dr. Hartshorne used strips of parchment for his ligatures. Dr. Jamieson, Professor of Surgery in Washington Medical College, Baltimore, has for a series of years, been employing the animal ligature in an extensive surgical practice; a number of his operations I have witnessed. He has used it in many amputations of the limbs and mamma; he has tied the carotid, the iliac, the femoral, the radial, the posterior tibial, the spermatic, and other arteries, with buckskin ligatures, and in no instance had secondary hemorrhage; and he states that he has never seen anything of his ligatures, and of course his wounds have generally healed by the first intention. He also states, as the result of his observation and experiments upon sheep, dogs, and other animals, that a capsule will surround the ligature, if the capillary vessels be not much disturbed, or the vessel will be surrounded by an abundance of lymph, and the ligature dissolved."¹ In the supplement to the same work, Dr. Reese also says: "Dr. Eve, of Georgia, employs exclusively ligatures

¹ Cooper's Surgical Dictionary, edited by Reese, vol. ii. p. 130. New York 1842.

made of the tendon or sinew of the deer, when he expects union by the first intention; they were originally suggested by Dr. John Bellinger, of Charleston, South Carolina."¹

Dr. McSweeney, of Cork, recommended the gut of the silkworm for ligatures; and Sir Astley Cooper at one time used catgut for the same purpose. He tied the femoral artery successfully with this kind of thread in a case of popliteal aneurism. But notwithstanding these successes, the animal ligature soon fell into disuse, and was remembered only as a historical curiosity.

To Mr. Lister is undoubtedly due the honor of having reintroduced the animal ligature into surgical practice; and he has shown that catgut, when properly prepared, possesses all the advantages for use in tying arteries that Physick claimed for other strings of animal origin, as well as for animal ligatures in general. Mr. Lister has elucidated this whole subject most thoroughly by observation and experiment, and, without doubt, the catgut prepared on his plan is superior to all other kinds of ligature in use to-day. If the catgut receive no special preparation whatever before using it, there is always a risk that it may prematurely soften in the warm plasma with which it becomes soaked when placed around bloodvessels in wounds, in which case the knot may slip or untie, or the catgut itself may be absorbed before the occlusion is complete—and thus it would fail to accomplish the purpose for which, as a ligature, it was applied. The method of preparation which Mr. Lister has found, after various trials, to be that which may be recommended is the following: Take one part of chromic acid, four thousand parts of distilled water, and two hundred parts of pure carbolic acid or absolute phenol. In other words, make a one-to-twenty solution of carbolic acid, not in water alone, but in an exceedingly dilute solution of chromic acid. This small quantity of chromic acid will have a very great effect upon the catgut. In the chromo-carbolic solution place an amount of catgut about equal in weight to that of the carbolic acid employed. If there is too large a proportion of catgut, it will not be sufficiently prepared; if there is too small a quantity it may become over-prepared. At the end of forty-eight hours, catgut steeped in such a solution is sufficiently prepared. It should then be taken out and, after drying, be placed in one-to-five carbolic oil. It is now fit for use. It must, however, still be kept in the mixture of carbolic acid and sweet oil (one part to five), in order that it may remain unchanged and not become over-prepared, and that its antiseptic condition may continue to be assured. The advantages of catgut, when treated in this way, for use as ligatures, are: (1) it is antiseptic; (2) a knot will hold with perfect security, and the noose will not prematurely dissolve in the plasma, nor disappear until it is replaced by a ring of fibrous tissue, and until the occlusion is perfectly safe; (3) the knot and noose will not prove too durable, that is, they will not be found to be insoluble and incapable of being absorbed at the right time; for if they should prove too durable they would work their way out by ulceration, like corresponding bits of carbolized silk or hempen thread. The spontaneous disappearance of catgut ligatures when set in wounds, is caused, not by any chemical solution of their structure, nor by any process of organization which they undergo, but by the invasion of leucocytes, under the operation of which they vanish, while new tissue takes their place; but, if they be over-prepared, this change does not occur, and they act like foreign bodies in general.

In applying the ligatures of prepared catgut, they should generally be drawn with sufficient force to divide the inner and middle coats of the artery; they should also be tied with a reef or square knot, and both ends should be cut off close to the knot. Doubtless, the tube of an artery may in many, per-

¹ Op. cit. p. 27.

haps in most, instances be obliterated by this ligature when the inner and middle coats are not divided by it. Indeed, Professor Jameson, of Baltimore, showed, more than fifty years ago, that the buckskin ligatures which he employed obliterated the arteries without cutting their inner and middle coats; and without destroying their continuity. Hence he opposed all indissoluble ligatures of whatever material; he declared it to be not only unnecessary but highly hazardous to cut the inner and middle coats of arteries, as recommended by Jones, etc.; and he agreed with Scarpa in regard to flat ligatures; but, by using buckskin, he had no need, like Scarpa, to remove his ligatures on the fourth day. Experience, however, has abundantly shown that the round is, for most cases, the best form for animal as well as for other ligatures; and that, in general, it is best to divide the inner and middle coats of arteries when applying them. Obviously the hæmostatic effect of animal ligatures is much increased by this proceeding, while the hazard is not increased in anything like the same proportion, especially if the wound be treated antiseptically.

Besides those mentioned above, other strings of animal origin have been successfully employed for ligating bloodvessels. Mr. Barwell has provided for that purpose narrow strips of the mingled yellow-elastic and unstriped muscular tissues which constitute the arterial wall, obtained by spirally cutting the aorta of the ox. Mr. Sterling has brought ligatures made of kangaroo tendon from Australia. Dr. Ishigouro, of the imperial Japanese army, has devised a ligature of whale tendon, which by some surgeons is strongly recommended. Dr. Wyeth has employed the sciatic nerve of a calf. Catgut, however, has some advantages which the others do not possess. It is to be had in abundance all over the world; it is strong and beautifully smooth; it is supplied of various sizes, admirably adapted for all the purposes of the surgeon; it is extremely cheap, and is easily prepared for use by the method described above. The only precautions to be observed in employing catgut for ligatures are: (1) to select that which is properly prepared for the purpose, as well as sufficiently strong; (2) to draw it between the thumb and index finger in order to free it from all excess of the carbolized oil in which it has been laid; (3) to adjust the knot with care; and (4) to leave the ends about one-fourth of an inch in length.

METALLIC LIGATURES.—The excellent results obtained by Sims, Emmet, and others, from the use of metallic sutures in operating for vesico-vaginal fistulæ, seemed to justify a belief that metallic threads—for instance, those made of silver, lead, or iron—really caused less irritation when applied, in wounds, than threads made of flax, hemp, etc.; and this belief was apparently confirmed by Simpson's experiments. Moreover, Ollier from observation and experiment was led to attribute to metallic threads the following advantages:—(1) They ulcerate and divide the tissues less rapidly; (2) they occasion less suppuration along their track; (3) they are sooner tolerated by the tissues through which they penetrate, and may be allowed to remain for a longer period; (4) they leave smaller cicatrices; and (5) these advantages are all due to the lower degree of irritation which attends their use. Ollier's experiments clearly showed the value of *fineness* in the metallic thread or wire; when wire having the thickness of a hair of the beard was compared, by its effects, with the thread commonly employed, the superiority of the former was undeniable. When the threads were of the same size the difference was less sensible; and, occasionally, for some days it could not be perceived. As a rule, however, threads made of metal had the superiority of finally becoming tolerated (that is, healed in, like ear-rings), whilst those of vegetable origin continued to excite suppuration. He found iron wire to be

as well tolerated as wire of any other metal; and, inasmuch as it could be produced of extreme fineness without being too much weakened, he used it exclusively in the end.¹ Thus, the employment of metallic sutures soon became popular among surgeons.

The non-absorbent and non-irritating character of metallic threads, as shown by their use for sutures in dressing wounds, naturally suggested to surgeons their employment for ligatures in tying arteries. Accordingly, Dr. Stone, of New Orleans, ligated the common iliac artery with a silver wire, in 1859. Since that time, Professor Gross has ligated the femoral, and Professor Agnew the brachial artery with the same sort of metallic thread. In 1866, Dr. C. H. Mastin, of Mobile, tied the external iliac with the same material. In applying the metallic, as well as the animal, ligature, both ends are cut off near the knot. The final disposition of the loop, however, is quite different in these cases. The portion of an animal ligature that is left in the wound is expected to become soft, infiltrated with leucocytes, and in the end entirely absorbed, as stated above; while the best that we can hope for a metallic loop, is that it will become imbedded in a deposit of organizable lymph.

APPRECIATION OF THE DIFFERENT LIGATURES.—The "*flaxen thread*" of Avicenna, and the *hempen thread* of recent times, are admirably adapted in respect to form, size, and strength, for the ligation of bloodvessels. But opposed to these good qualities is the fact that these threads are liable to cause much irritation by their presence in wounds, not only because they are foreign bodies, but also because a peculiar fermentation of an acid nature may occur, which has in them its starting point and seat. For example, Mr. Lister, in operating for goitre, used six hempen ligatures carefully rendered antiseptic by means of the carbolic lotion. During the first eight days everything went on in typical fashion according to the antiseptic method. On the ninth day, however, some pus was observed mingled with the discharge. The purulence increased, and in a month one of the hempen ligatures made its escape. In six days more, four others came away, altogether unaltered in appearance. They were submitted to careful examination. They had a sour odor, and, applied to litmus paper, gave an acid reaction; that is, the natural alkaline reaction of blood-serum had been changed to acidity by a peculiar fermentation, differing from putrefaction, which would, if possible, have made the blood-serum still more alkaline. Under the microscope, the interstices of the threads were found loaded with little organisms to which Mr. Lister gave the name of *granuligera*, occurring in groups of twos, threes, and fours, etc., quite distinct from the chains in which ordinary bacteria occur. These micrococci, developing in great abundance in the interstices of the hempen ligatures, produced an acid fermentation of the serum in its most aggravated form. The acid serum caused irritation, and thus the carbolized ligatures which, otherwise, might have become encapsuled, gave rise to suppuration. The remaining ligature was ultimately discharged, unaltered in appearance, in the same manner.² Here, then, we have an illustration of the great disadvantages which may arise, even under antiseptic treatment, from the use of hempen and other ligatures made of vegetable fibres.

Carbolized Silk (that is, uncolored silk which has lain for half an hour in a mixture of melted wax and carbolic acid) is not, in my opinion, open to this particular objection for use in the ligation of bloodvessels. G. Simon, as the result of many experiments, did not perceive any important difference be-

¹ Gaz. Hebdomadaire, 1862, pp. 135, 181, 261, 359.

² Med. Times and Gaz., Feb. 5, 1881.

tween fine well-twisted silk, and fine metallic threads, for sutures in vesico-vaginal fistulæ.¹ The advantages of carbolized silk are that it is antiseptic, strong and smooth, easily obtained, easily applied, and easily removed. Its disadvantages are that it is a foreign body, and that it finds its way through the arterial tissues by ulceration.

Metallic Ligatures, by reason of their non-absorbent properties and their inability to become soaked with decomposing discharges, possess a special advantage. But they cannot always be applied with ease; and for the purposes of general ligation they are certainly not well adapted. It remains, however, for future experience to determine what their true value is for ligating large arteries in their continuity, such as the iliaes, the femoral, brachial, etc. But it seems at present quite probable that, like other non-irritating ligatures of a permanent character, they will, for the most part, find their way out by ulceration, and therefore will be attended with the dangers peculiar to that process, just the same as ligatures of carbolized silk. Indeed, I have no doubt that, *for general purposes*, carbolized silken thread is preferable to every other kind of *permanent* ligature in use for tying arteries.

Animal Ligatures, that is, the ligatures made of buckskin, deer sinew, catgut, kangaroo sinew, whale tendon, and ox aorta are, in their nature, not permanent, and they possess, when properly prepared, a great superiority over all other ligatures whatever, inasmuch as they do not act as foreign bodies in the wounds where they are placed. They lie there harmless and unirritating, in contact with the tissues, and, becoming infiltrated with leucocytes, are, in due time, entirely removed by absorption; new fibrous bands or rings, however, taking their place. The tendency of some of these ligatures to soften prematurely, and of their knots to slip or become untied, whereby their hold upon the wounded vessel might be loosened before the proper time, was formerly an objection to their use in tying large arteries; but this objection is no longer valid, for the material can now be treated in such a manner as to make the knot entirely safe, and, at the same time, impart greater flexibility as well as strength to the thread itself. For the general purposes of ligation, I believe that carbolized catgut, prepared on Mr. Lister's plan, described above, is superior to every other kind of ligature; and the soundness of this belief is attested by the experience of surgeons in every part of the globe, as well as by considerations which I have already adduced. In short, the catgut thus carbolized is a non-irritating ligature which seems to fulfil all the conditions of a perfect hæmostatic, combining the security and universal applicability of the ligature, with absence of the bad effects of a foreign body in the wound. After the knot is tied, both ends of this ligature should be cut off, and the wound permanently closed.

IV. TORSION.

Twisting the cut ends of arteries was distinctly recognized by Galen as an important means for restraining the flow of blood therefrom. Aëtius, Paulus Aegineta, and Rhazes also recognized torsion as a hæmostatic measure of importance. Subsequently it became obsolete. In 1829, Amussat revived its use by proving from experiments on animals that it was a safe and efficient means of stanching hemorrhage from many wounded arteries. Soon afterward Thierry followed to the same effect. Velpeau, however, first employed torsion on the human subject. In the same year Liber, Fricke, Dieffenbach,

¹ New Syd. Soc. Year-Book, 1862, p. 181.

and others, made numerous trials thereof in Germany, seemingly with entire success. The French surgeons, Louis and Delpech, met with several failures. The subject was deemed of such importance by the Institute of France as to require a thorough examination, and, accordingly, it was referred to Baron Dupuytren. His report was unfavorable to the method, except in its application to small arteries. Then torsion went out of use again, to be revived once more, however, by the late Professor Syme. During late years it has met with great favor at Guy's Hospital, London, from Mr. Bryant and others; but in America it has not been received with much favor, though at the Pennsylvania Hospital, Philadelphia, Dr. Hewson used it with success.

The torsion of arteries for suppressing hemorrhage may be practised in various ways. Amussat recommended that the artery should be drawn out about half an inch by one pair of forceps; that it should then be seized by another pair of forceps, and the end twisted off by about half-a-dozen turns. Fricke advised that the end should not be taken off, but merely twisted around six or eight times, according to the size of the vessel. Thierry simply seized the artery by its end and twisted it. Doubtless, hemorrhage from very large vessels may be permanently suppressed by torsion, the artery being placed thereby in a lacerated condition. The inner and middle coats are retracted, and the outer one is twisted into a kind of valve, which covers them. A coagulum next forms within the tube, blocking up its extremity; inflammation then occurs, gluing together the lacerated coats of the vessel; the twisted end sloughs off, and the tube becomes permanently occluded up to the nearest branch.

Two methods of twisting the ends of divided arteries, so as to arrest the bleeding, are now in vogue. The first is substantially that of Thierry. To

Fig. 395.



Slide-catch artery torsion and needle forceps.

perform his operation strong forceps, having serrations which are not sharp enough to cut the artery, are required. (Fig. 395 or Fig. 396.) The end of

Fig. 396.



Professor Wood's artery forceps.

the artery being seized, it should be drawn well out into view, and the forceps should be merely rotated until all resistance ceases, but not to the extent of twisting off the end of the vessel. This operation is also called that of *free torsion*.

The second method is that of Amussat. (Fig. 397.) According to this author, the artery should be taken hold of and drawn out five or six lines from the surface of the wound by forceps of suitable breadth, and furnished

with a slide-catch for fastening the blades together when closed; the vessel must then be separated from the surrounding parts with other forceps, or with a small knife, until it becomes entirely isolated. Next, the artery must be seized with the second forceps, or with the fingers of the left hand, at the point where it emerges from the surrounding soft parts, and held firmly fixed.

Fig. 397.



Showing Amussat's plan of making torsion.

The artery is then to be turned round on its own axis, or twisted with the first forceps, until the end is torn off, when the bleeding will be certainly stopped. Below the fixed part no blood is found in the tube of the artery. If no forceps be at hand, the artery, in urgent cases, may, as was proposed by Galen, be pierced with a needle or with a nail, and so twisted round. Torsion performed by this method is called *limited torsion*.

A very ingenious instrument for the torsion of arteries has been devised by Dr. Addinell Hewson (Fig. 398), which combines, in one, the two forceps employed by Amussat and others.

Fig. 398.



Hewson's artery torsion forceps.

The advantages claimed for torsion are the following: (1) The facility with which it can be performed. In reply, I may say that I have seen as much time consumed in twisting an articular branch in the arm, before the bleeding could be stayed (and that, too, by one entirely familiar with the work), as would have sufficed for an amputation and all the subsequent dressings by the old method; and, further, that I have seen it fail altogether in more than one instance, compelling a resort to the ligature before the rebellious artery could be secured. The use of anæsthetics has, moreover, in great measure, removed the necessity for excessive haste in operating. (2) Greater safety is claimed for torsion. I am not aware that we possess the means for making any extended comparisons between this and other methods, but my own observation furnishes instances in which secondary hemorrhage followed torsion even of sound vessels, a circumstance which is, I think, rarely met with after ligation. (3) It is said that by torsion the healing is facilitated, because of the wound's being free from all irritating or foreign bodies. Yet the end of the twisted artery, comminuted and bruised, frequently separates as a slough, and becomes as much a foreign body as a ligature. The experience of both Velpeau and Manec shows not only this, but also that the healing after torsion is as slow as the healing after the ligature; indeed, according to the authority last named, it is even more tedious (Agnew). That large arteries, such as the femoral, brachial, etc., have been safely treated by torsion, is no doubt true;

that secondary hemorrhage has followed torsion, and life been sacrificed, is, however, equally true; and I am not prepared to admit that torsion possesses any superiority over the ligature of carbolized catgut; indeed, I do not believe that torsion equals it for general use as a hæmostatic measure.¹

V. CONSTRUCTION OR CRUSHING OF ARTERIES FOR THE ARREST OF HEMORRHAGE.

Dr. S. Fleet Speir, Surgeon to the Brooklyn City Hospital, has devised an instrument for the instantaneous hermetical closure of arteries without the use of ligatures or other foreign substances to be left in the wound, which he calls the "artery constrictor." (Fig. 399.) Professor Hamilton and others speak highly of it from experience.

Fig. 399.



Speir's artery constrictor.

This instrument consists of a flattened metal tube, six inches (more or less) in length, open at both ends, with a sliding steel tongue running its entire length, and having a vise-like arrangement at the upper end by which the tongue may be protruded from or retracted within the tube or sheath. The lower end of the tongue is hook-shaped, so as to be adapted to the artery to be constricted. It is so shaped that, having grasped the artery, it can be made to contract upon it by means of the vise at the upper end, which draws the tongue into the sheath.

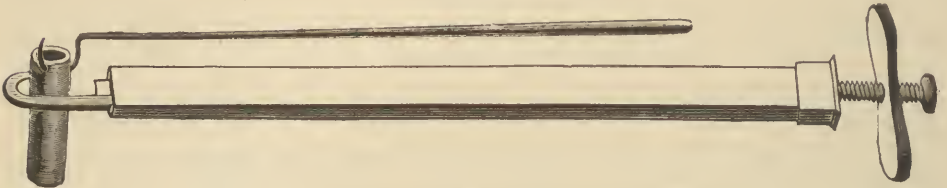
The hook of the tongue is so shaped and grooved as to form only a compressing surface, by means of which the artery, when acted upon by the force of the vise, is compelled to assume the form of the curve of the tongue, and the artery is constricted in such a way that the inner and middle coats give way, but the external coat is preserved intact. The severed inner and middle coats retract, curl upon themselves, and are driven down the artery, in the form of an invagination or plug, by the continued pressure of the grooved tongue as it passes into its sheath. The artery may now be slipped out of the instrument, and it will be found that the external coat has been compressed at the point where it was in contact with the instrument, and the inner and middle coats will be divided and invaginated on either side of the constriction. (Figs. 403, 404.) This invagination of the inner and middle coats is of itself sufficient to check the flow of blood. As soon as the current of blood is arrested in the tube, a coagulum forms upon the invaginated inner and middle coats, and this completes the occlusion. (Figs. 404, 405, 406.)

The application of the constrictor is very simple. The artery is to be caught up by a tenaculum (Fig. 400), or by forceps (the latter is preferable), and the tongue of the constrictor placed around the vessel; the tongue is then drawn tightly upon the artery by means of the vise-like arrangement

¹ In regard to the employment of torsion for the arrest of hemorrhage, Professor Esmarch (Surgeon's Handbook, p. 185) says: "If there be no antiseptic material at hand for ligatures, the arteries may be closed by torsion;" and I am fully convinced that this is the only contingency which renders the use of torsion advisable.

at the upper end of the instrument. As soon as the screw turns with a considerable degree of resistance, or the inner and middle coats are seen to be sufficiently invaginated, by observing their movements in the open end of the

Fig. 400.



Showing how the artery is placed within the grasp of the constrictor.

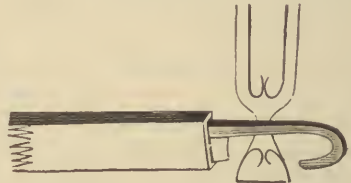
artery, the instrument is to be detached from the artery, and the operation is completed. The length of time required for the operation is about one minute, or more, according to the size of the artery.

Fig. 401.



The constrictor applied and closed.

Fig. 402.



The constrictor in the course of removal.

Fig. 403.



Diagram showing the first effects of constriction.

Fig. 404.



The coagulum.

Fig. 405.



Showing the external appearance of the constricted artery.

Fig. 406.



Showing the effects of constriction applied in the continuity of an artery.

Professor Hamilton says that, in the experiments on the cadaver which he has made with Dr. Speir's instrument, he has always found the inner and middle coats of the artery invaginated or recurved enough to completely close the channel, and likewise to resist the flow of water forced in by a Davidson's syringe. In operating on large arteries, the tongue of the constrictor must be drawn into the sheath further than is required in operating on small arteries. This is the one point necessary, and to be attended to, in constricting large arteries, namely: a perfect invagination of the inner and middle coats must be secured. This invagination may be made as complete as may be desired, by drawing the artery up into the tube with the hook which grasps it, as far as may be needed to effect the object. The instrument may be made with a stop to indicate when a sufficient invagination has been reached; but experience has shown the *touch* to be the best guide for the

operation. By a continued traction, made through the constrictor upon the outer coat of an artery, after the invagination is once commenced, the inner and middle coats may be peeled up and pushed entirely out of the external coat, and thus the latter may be drawn through the sheath of the instrument, freed entirely from the other tunics; wherefore, the operator has it in his power to make the invagination as extensive as he may wish; and, if he always takes care to make the invagination perfect, failure in using the instrument will be impossible. In amputations, etc., it is always advisable to loosen the tourniquet and allow the blood to flow into the main artery before removing the constrictor, for thus will be secured upon the invaginated tunics a perfect clot, which, afterwards, can hardly be displaced.

Professor Hamilton also says that the experiments which have been made with Dr. Speir's constrictor, under his own observation, induce him to believe that it will, at least, prove superior to acupressure and torsion; and that it is quite competent to close hermetically the femoral artery and other vessels of the same class, after amputations, etc. But, time enough has not elapsed since the introduction of the instrument, in 1871, to enable us to decide as to its merits by the test of experience. A further judgment must therefore be reserved for more extended observation.

For convenience, the constrictor may be made with three sizes of tongues, to be used with one tube, so as to fit more nearly the cylinders of different arteries. Furthermore, Professor Hamilton advises those who use Dr. Speir's constrictor to order it from his instrument maker, or to copy it with great care from the original, and not to attempt to construct it from any description, since, upon the fashioning of the hooks, the value of the instrument in great measure depends.

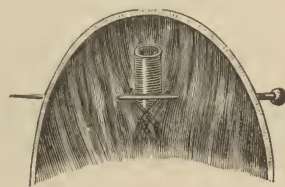
VI. ACUPRESSURE.

In December, 1859, this method of hæmostasis was first presented to the world by the late Sir James Y. Simpson, in a communication to the Royal Medico-Chirurgical Society of Edinburgh. The instruments required for operating on this plan are very few and simple. They are (1) bayonet-pointed pins, varying in length from three to five inches, with glass or wax heads to facilitate their introduction, (2) needles threaded with fine iron wire, and (3) loops of slender iron wire, well annealed, and five or six inches in length. On the cut surfaces of flaps the ordinary sewing-needle answers perfectly well. There are several methods of employing the pins in order to exert on the wounded artery the compression which is desired; but, practically, they may be reduced to three.

1. DIRECT COMPRESSION (Fig. 407) is made by a pin thrust through the flap, passed over the artery, thrust into the flap again, and brought out of it on the side opposite to the point of entrance, in such a manner as to firmly compress the end of the severed artery against the muscle on which it lies; in other words, the wounded artery is secured on the face of the stump by inserting a pin, as one would secure the stem of a rose on the lapel of his coat.

2. COMPRESSION WITH WIRE is effected by passing the point of the pin or needle under the vessel, then casting over it and in front of the artery

Fig. 407.

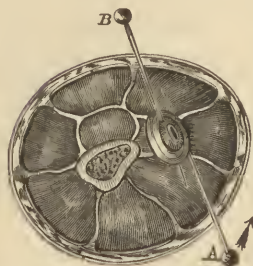


Acupressure by the first method.

a loop of iron wire which is to be tightly fastened to the shaft of the pin or needle; the pin is then to be passed through the opposite flap. A good plan for using the wire is to place a loop of it under the point of the pin or needle already inserted, carry both ends of the loop across in front of the artery, then pass one of them beneath the head of the pin or needle, and, finally, fasten the two ends together by twisting them as tightly as may be desired.

3. COMPRESSION BY TORSION (Fig. 408) is made by transfixing with a pin the

Fig. 408.



Acupressure by torsion.

face of the wound or stump, an inch or more on the side of the artery at *A*, then carrying the head of the pin half-way around the face of the stump or wound to *B*, and there thrusting the point of the pin into the tissues beyond, so as to hold it securely. The pins or needles should not be left in more than forty-eight hours for the larger, and twenty-four hours for the smaller arteries; and even a much less period has been found sufficient to obtain permanent occlusion.

To these methods should be added that of the late Dr. Buek, of New York, which consists of torsion combined with transfixion. In applying it, the artery is first seized with a torsion forceps (Fig. 395) and twisted around on its axis two or three times, when the pin is

to be thrust transversely through the cylinder of the artery, and then fixed in the surrounding tissues.

Mr. Bryant remarked, at a recent meeting of the Royal Medical and Chirurgical Society,¹ that "acupressure had been almost abandoned, because, in the case of severed arteries, it was frequently followed by secondary hemorrhage, the vessel not being occluded long enough to allow of permanent clotting." Professor Esmarch makes no mention whatever of acupressure in his *Surgeon's Handbook*; and I think that he is quite right, because, though historically of importance, it is not of much practical value as a hæmostatic measure.

VII. AËRTERIVERSION.

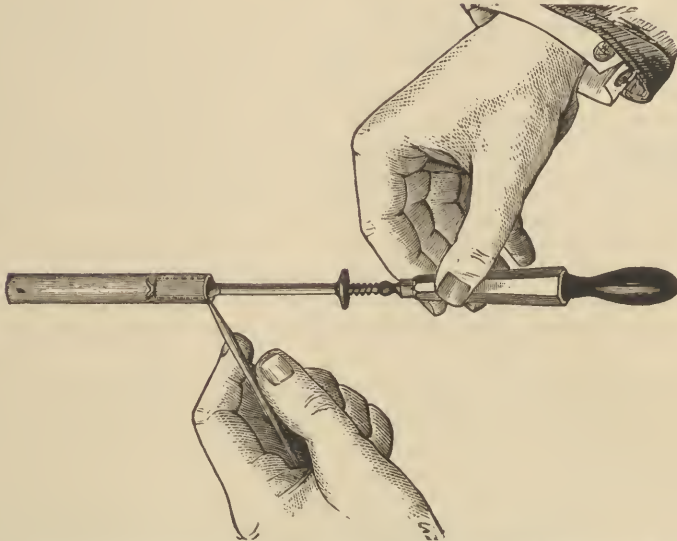
Dr. G. C. E. Weber, of the Medical Department of the University of Wooster, at Cleveland, Ohio, proposes to constrict the mouths of arteries divided in amputations, by turning over their ends with a little instrument, called an *aërteriverter* by Dr. Weber, but quite similar to the fine double hooks, operated by a sheath, the invention of M. Lüer, of Paris, and called by him *fixateur à gaine*. With this instrument the ends of divided arteries may be retroverted, as one turns over the cuffs of his coat in rolling up the sleeves. This method is designed to reinforce the cut extremity of an artery by the duplicature of its walls, thus surrounding its open mouth with such a quantity of arterial muscular and elastic fibres as to effectually close it against the impulse of the heart's action.

The operation is easily performed by introducing the hook-end of the instrument into the artery up to the point where the reflexure of its walls is to be made, and there planting the hooks in the inner and middle coats; then by grasping the end of the artery with forceps, held in the other hand, and slipping the section of the vessel embraced between the two instruments

¹ *Lancet*, March 26, 1881.

over the first, on the hooks as over a fixed point (Figs. 409 and 410), the inversion of this part of the artery is readily secured. After the retrover-

Fig. 409.



Showing the aërteriverter introduced up to the point where the artery is to be turned over, with the double-hook extending a little beyond it.

sion is effected, there always remains a strong tendency for the vessel to unroll itself again, due to the pulsatory movements of the artery itself; this may

Fig. 410.



Showing the appearance of the artery when the inversion is just completed, prior to the removal of the instrument

be met by inserting a fine, smooth, steel peg, made of the end of a number twelve English sewing-needle. (Fig. 411.)

Fig. 411.



Showing the retroverted part of the artery fastened with a delicate little peg, prepared by breaking off the end of a fine sewing-needle. The peg, when allowed to remain, apparently does no harm.

Dr. Weber has operated by this method with success on the femoral, the brachial, and the anterior and posterior tibial arteries, in amputations of the thigh, arm, and leg.¹ He claims, from his own experience, that this method of treating arteries is a justifiable proceeding, and that it possesses a decided advantage in leaving scarcely anything but living tissues in the wound. The value of this operation, however, is not yet determined.

¹ Medical Record, pp. 308-310. New York, 1875.

VIII. CAUTERIZATION.

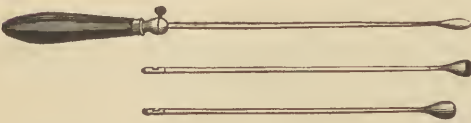
The application of a *hot iron* is one of the most ancient means of arresting hemorrhage. It acts mechanically by forming, out of the charred tissues, a plug, which restrains the outflow of blood. It is by no means an obsolete method of procuring hæmostasis. Boyer relates an instructive example:—

A servant was playing on a Jew's-harp; some one gave him a blow which drove the instrument into his mouth; the blood flowed; a surgeon was called, who directed astringent gargles; they did not answer; he next stuffed the mouth with lint, and bandaged the upper and lower jaws together, but to no purpose; the bleeding continued for twenty-four hours, and the patient was almost exhausted, when Brasdor, a professor in the ancient school of surgery, who related the case, was called in. His first care was to see where the blood came from. He emptied the patient's mouth, and washed it clean. He saw the hemorrhage proceeding from the inferior and anterior part of the tongue; he heated an iron slyly, and put it on the place whence the blood flowed; an eschar was formed, the bleeding stopped in an instant, and the patient got well.¹

In this case the ranine artery was wounded; a ligature could not be applied, owing to the inaccessibility of the lesion, and compression was impracticable from the softness and mobility of the tongue. In all similar cases of hemorrhage from the mouth or throat, the actual cautery furnishes the best means of arresting it. The cautery, too, is often employed with success to stop the flow of blood from small, deep-seated vessels lying beyond the reach of the ligature; also where there is free oozing from numerous points, such as occasionally follows operations on the maxillary bones, operations for the removal of piles, and sometimes excisions of the tonsils.

The *cautery-iron* consists of a knob of that metal at the end of a long shaft, fastened to a convenient handle. The shape of its extremity may be globular, or olivary, or button-like, etc., each form being adapted to some special

Fig. 412.



Straight cautery-irons.

Fig. 413.



Bent cautery-irons.

Fig. 414.



Blowpipe for heating the cautery-irons.

condition requiring its use. (Figs. 412, 413.) It may be heated in the flame of a common spirit-lamp, or in that of a blowpipe made for the purpose. (Fig. 414.)

Cautery-irons may be extemporized from stove-pokers, knife-blades,

¹ *Traité des Maladies Chirurgicales*, t. i.

knitting-needles, iron-wires, etc. They may easily be extemporized from pieces of telegraph wire by rolling up one end into a spiral form, filing the other end to a point, and pushing it into a piece of wood to serve as a handle. (Fig. 415.)

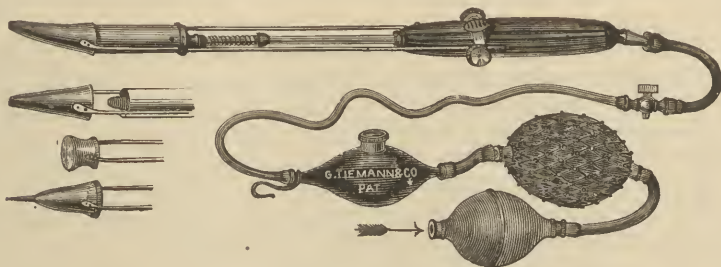
In applying the cautery for hemorrhage, care must be taken that the iron is heated only to a dull red color; for, should it be raised to a bright red or white heat, it may defeat its own purpose by destroying the artery too extensively, or by bringing away the eschar stuck fast to the iron, thus leaving the vessel unclosed. When practicable, the heated iron should be passed through a glass tube down to the bleeding orifice, in order to shield the surrounding parts from injury. The late Dr. George McClellan, of Philadelphia, in this way, introduced red hot wires of the largest size down the throat and up the nostrils, to check the hemorrhage from bleeding vascular tumors, with perfect safety.

Fig. 415.



Cautery-irons improvised from telegraph wire, after Brandis. (Esmarch)

Fig. 416.



Tiemann's thermo-cautery apparatus.

The *thermo-cautery instrument* is a very ingenious and useful contrivance, introduced by Paquelin, by which the *cauterizer* or platinum point may very quickly be raised to a bright red or even a white heat, and may have the same degree of heat kept up for any length of time without any difficulty whatever. It is peculiarly well adapted for operative procedures in the mouth, vagina, and rectum. By attaching a blade to it, incisions that are bloodless may be made, and with an *écraseur* of platinum wire, tumors may be removed in a bloodless manner also.

In preparing the instrument for use (Fig. 416), the button-screw cap is to be removed from the receiver, and benzine or gasoline is to be poured into it until the wool which it contains is saturated with the liquid, but no more than that. On replacing the cap, the receiver itself may be suspended from a button-hole by means of the hook which projects from one end of it. By working the elastic bulb or pump at the lower end of the instrument, air is forced into the receiver in a steady stream, where it becomes saturated with benzine or gasoline; thence the mixed gases are forced upward through the platinum cone at the upper end of the instrument, into the platinum point, No. 1, which is attached to it. Ignition may be started with a match. The degree of heat is adjusted to that which is required, from dull red to white, by drawing the platinum cone down upon the cylinder. A stopcock regu-

lates the volume of mixed gases to be passed. Platinum points of various patterns, *e. g.*, knife-shaped, No. 2, flat, No. 3, and needle-pointed, No. 4, are easily attached.

APPRECIATION OF THE VARIOUS HÆMOSTATICS.

Most of the agents employed by surgeons for the suppression of hemorrhage, have been so thoroughly discussed in the foregoing pages, that but little remains to be said concerning their relative value or importance. *Cold* is unquestionably a most valuable, as well as an ancient and safe, means of arresting hemorrhage. Fresh cold air and carbolized iced water (one part to one hundred) afford the most convenient and useful forms for applying it. The latter may be squeezed out of a sponge in a shower, or squirted from a syringe in a small stream, upon the bleeding surface. [*Hot* water is often of value in arresting capillary hemorrhage.] Among styptics, the best are *alcohol* and the *oil of turpentine*; the latter to be applied directly to the bleeding apertures, on dossils of lint. Persulphate and perchloride of iron are peculiarly objectionable, inasmuch as their use is attended with the formation of hard, insoluble coagula, which are removed with great difficulty, and which, if allowed to remain, interfere very much with the dressing and healing of deep wounds, and with the performance of any surgical operations that may afterward be needed. The ferric salts should be restricted in their use as styptics to leech-bites, to parenchymatous hemorrhages, and to superficial injuries.

Compression, both as a temporary expedient and as an adjuvant to other measures for arresting hemorrhage, is of extreme utility. The value of digital compression as a temporary hæmostatic when large vessels are wounded—especially when promptly, that is, seasonably applied, cannot be over-estimated. Compression by tourniquets is indispensable. The elastic bandage and tubing, or ligature, of Esmarch, afford, also, a most excellent means of applying pressure for the temporary arrest of hemorrhage, in a wide range of cases. Tampons, too, in some wounds are absolutely necessary.

Neither *acupressure* nor *torsion* affords anything like the same security that attends the application of ligatures to wounded bloodvessels. *Constriction*, by Dr. Speir's instrument, is superior to both torsion and acupressure, because with it the lumen of the artery can certainly be filled up by the incurvations of the divided inner and middle coats. The success of *arteriversion* is not yet assured.

Ligation affords the greatest security that is possible against the return of hemorrhage, provided it be made with threads of animal origin which have been properly prepared for the purpose; for instance, with ligatures of catgut prepared by Mr. Lister's method. The grounds on which rest the superiority of animal ligatures in general, and that of the prepared catgut ligatures of Mr. Lister in particular, over all others, have already been set forth; it is not necessary to recur to them in this place.

The *actual cautery* is indispensable for suppressing hemorrhage from small deeply-seated arteries, so placed that they cannot be tied or compressed; for example, in the mouth, the fauces, the nares, the rectum, etc.; and from parts which, by reason of weakening or disintegration, will not hold a ligature.

INTERNAL HÆMOSTATICS.

There are a few remedies which may assist not a little in suppressing hemorrhage, when administered internally, provided that the bleeding vessels are

small, like those of the nostrils, uterine cavity, pulmonary cavity, etc. The most important of these remedies are, (1) oil of turpentine, given in doses of ten drops suspended in mucilage or simple emulsion, every fifteen or twenty minutes; (2) fluid extract of ergot, twenty or thirty drops every half hour; (3) gallic acid, ten grains every hour; (4) aromatic sulphuric acid, fifteen drops every two hours, mixed in water; (5) opium, given in doses sufficient to allay restlessness and mental anxiety—a most valuable remedy against hemorrhage; and (6) acetate of lead, in doses of not less than two grains every hour or two, combined with opium, a combination which has sometimes suppressed hemorrhage after everything else has failed.

AFTER-TREATMENT OF HEMORRHAGE.

After the bleeding is stanchcd, everything which could bring it on again must be carefully avoided. To that end the patient himself, as well as the injured part, must be kept at perfect rest. In cases where the bleeding has been stopped mainly by applying pressure, it oftentimes is advisable to continue to compress the main trunk of the artery on the cardiac side of the wound, as well as the wounded vessel itself at the place of injury, until the period of reaction is fully passed, and perhaps even longer than that, lest the occluding coagula should be driven out by the increasing force of the blood-stream.

The surgeon must also provide against the return of hemorrhage by causing, if possible, union of the wound throughout to occur by the first intention, with correspondingly speedy healing of the vascular lesion itself. He will, therefore, employ antiseptic dressings and the antiseptic plan of treatment, and do whatever else seems requisite to fulfil this indication. But when, owing to the nature of the injury, there will be suppuration—as, for instance, usually happens in gunshot and contused wounds—he must seek to prevent the recurrence of hemorrhage by providing for the immediate discharge of matter by means of drainage-tubes inserted in the wound (Fig. 417), and by the em-

Fig. 417.



Chassaignac's drainage tube and drainage trocar.

ployment of "through drainage" also, whenever practicable. If the wound become inflamed, he must promptly abate the inflammation by applying an ice-poultice, or iced-water irrigation, or an ice-bag to the inflamed part; and by administering cooling drinks, with a bland diet. He must protect the patient from constitutional infection by the absolute cleanliness as well as the antiseptic quality of the dressings, by the freshness and purity of the air he breathes, and by the nourishing, sustaining, or healing quality of the food he eats. In all wounds implicating large bloodvessels, where sloughs must be discharged, the surgeon must have a close watch kept by the attendants on the patient, so as not to be taken unawares by the occurrence of secondary hemorrhage; and they must be instructed beforehand what to do pending his arrival. Especially must the surgeon take care to prevent the burrowing of purulent matter in these cases, and the occurrence of inflammation in the perivascular tissues, by prompt incisions, by complete drainage, by thorough antisepsis, and by judi-

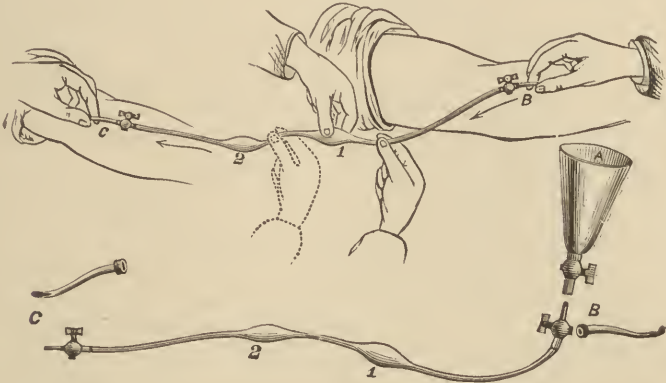
ciously employing the antiphlogistics mentioned above, when union by the first intention cannot be obtained.

When, however, the loss of blood has been very great, or the patient has barely escaped with his life, and lies very low in consequence of it, something quite different must be done. In the first place, great pains must be taken to avoid the occurrence of a fresh syncope, for, with the highly anæmic condition of the brain already existing, it might readily prove fatal. His head must, therefore, be kept in a depressed position, in order to make the blood gravitate toward his brain from the other parts of his body. His head must not even be raised for the brief moment of time required to slake his thirst, which is apt to be intense; but drink must be freely given him through a bent tube, or from an "invalid's cup," long ago devised for the purpose, while his head remains low or depressed. The arms and legs of the patient must not be allowed to hang down from the couch on which he lies, because the blood would gravitate into them away from the brain, and thus the cerebral anæmia would be increased. On the contrary, the limbs may be raised up with advantage, and likewise be tightly bandaged from fingers and toes to trunk, in order to lessen the area of the circulation as much as possible, and thus secure more blood for the brain. The drink should consist of lukewarm milk, to which a little good wine or brandy is added, and should be given with a view to rapidly replenish the empty bloodvessels; and, as soon as it can be prepared, freshly made beef-tea should also be given. But the quantity and the effects of the alcoholic stimulants are to be closely watched, lest harm be done by their unrestricted use. The fumes of strong liquor ammoniæ should be applied to the nostrils in order to increase the frequency and depth of the respiratory movements. Fresh, cool air should be freely admitted to the patient; but, at the same time, the coldness of his body should be combated by the application of dry heat. During the convalescence from exhausting hemorrhages, tincture of the ferric chloride, good wine, and a generous diet are chiefly the means by which the anæmia, the debility, the cardiac palpitations, and the nervous irritability are to be overcome. In many cases, however, something further still is required from the surgeon; and that something is the operation of transfusion, performed in order to save life. This operation may be defined to be the injection of the blood of one person into the bloodvessels of another, for the purpose of summarily effecting the relief of extreme exhaustion.

TRANSFUSION.—In many instances that occurred during the late civil war, great losses of blood, from wounds which did not kill at the time, were followed by a state of anæmia and general debility from which the patient could not be raised by even the most assiduous employment of the most nutritious kinds of food and of the choicest forms of alcoholic stimulants, with the chloride of iron, or the citrate of iron and quinine; and the consequence was that such patients perished miserably from anæmic exhaustion some considerable number of days after the bleeding had been arrested. The correctness of this statement is attested by numerous cases related in the Medical and Surgical History of the War. Now, in looking back over my own experience during this period, I have no doubt that some, perhaps most, of the cases of traumatic hemorrhage belonging to this category, which came under my own observation, might have been saved by transfusion, if seasonably performed. For this reason, I believe that the operation of transfusion will hereafter prove very useful in military as well as in civil practice, and that it justly claims the serious attention of all surgeons. The various modes of performing the operation have already been described in the first volume of this work, and I do not intend to repeat them here; but with a view to

emphasize the subject according to its importance, as well as to offer another and a somewhat better instrument for performing the operation, the accompanying woodcut (Fig. 418) is presented:—

Fig. 418.



Transfusion apparatus of B. E. Fryer, M.D., Surgeon U. S. Army.

This instrument is that of Aveling, modified by adding another bulb to the tube, and by having both tube and bulbs cast of the rubber into one piece. By the additional bulb, time can be saved in performing the operation, and the blood can be kept moving through the tube almost continuously. By having the tube and bulbs in a single piece, the metal portion which couples them in Aveling's apparatus is done away with, and thereby the risk of blood lodging and coagulating is diminished, while, if necessary, the whole apparatus may be more completely compressed. In Fryer's instrument, as in Aveling's, there are no valves; but in Fryer's the inner wall is perfectly smooth throughout, and the opening from tube to bulbs gradually slopes, thus entirely avoiding corners in which the blood might stagnate and coagulate.

The apparatus of Fryer consists of two parts, one of which is intended for immediate and the other for mediate transfusion. The addition of a glass vessel, marked A, which can be fitted to the tube at B, makes an instrument which can be used for mediate transfusion when desired.

The manner of using the instrument for *immediate transfusion* is as follows: The canula marked B is placed in the giver's vein; that marked C in the vein of the receiver. The tube and bulbs having been filled with warm water, or, better still, with a warm saline solution (consisting of sodium chloride, grs. 60, potassium chloride, grs. 6, sodium phosphate, grs. 3, sodium carbonate, grs. 20, and water, twenty ounces) are then to be adjusted to the canulae, and the blood allowed to flow into the apparatus. The canulae being steadied by an assistant, the tube is to be nipped tightly between the fingers, close to the giver's end, and then the bulb marked 1 is to be compressed, and the blood of course forced on toward the receiver. While this bulb is still held flattened, the nipping of the tube at the giver's end is to be relaxed, and the portion of tube between the bulbs is to be nipped instead; bulb No. 1 should then be relaxed, and bulb No. 2 should be compressed and held; next, the tube is to be tightly nipped at the receiver's end and held to prevent regurgitation, and the whole apparatus allowed to refill from the giver's arm. The same manipulation is to be repeated until blood enough is transfused. A considerable degree of force sometimes must be used in sending.

blood or other liquids into the veins. A few drops of liquor ammoniæ may be injected into the bulbs, now and then, with a fine-pointed hypodermic syringe, in order to more effectually prevent coagulation.

The manner of using the apparatus for *mediate transfusion* is as follows: The glass vessel marked A in the cut is applied to the tube in place of the giver's canula, marked B, and has poured into it the blood to be transfused. The instrument is to be applied to the receiver's arm, and afterward to be worked in the manner directed above. If this blood be not defibrinated and strained, three or four drops of liquor ammoniæ must be added to each ounce, in order to prevent coagulation.¹ For other methods of performing this operation, and there are several, the reader has already been referred to the first volume of this encyclopædia.

When a patient is in danger of perishing from hemorrhage, resort should at once be had to transfusion, that is, to the introduction of blood from a sound person into the empty vessels of the patient. "I have seen," says Professor Agnew,² "patients who were dying from epistaxis rescued from the very verge of dissolution by the timely passage of a few ounces of blood into a vein of the arm. Not only is this operation indicated in excessive hemorrhage, but I have known several cases of obstinate anæmia greatly benefited by the same practice." The cases requiring transfusion may be briefly outlined as follows: (1) Those in which the hemorrhage occurs from large bloodvessels, and cannot be stanchèd until death is imminent. (2) Those examples of prolonged epistaxis, also, wherein death has become imminent. (3) Those instances of post-partum hemorrhage in which reaction cannot take place unless blood obtained extraneously is at once poured into the empty vessels. (4) Those cases of anæmic exhaustion, caused by great losses of blood, in which the ordinary measures prove insufficient to raise the patient; this class will be found to be unhappily numerous, especially among the wounded in time of war. (5) Inasmuch as depression from the loss of blood is one of the most important factors concerned in the genesis of blood-poisoning in surgical practice, it is often right to overcome it by transfusion.

The blood for transfusion must in all cases be taken from a human being, as that of animals does not answer the purpose. The donor should be a person in good health, entirely free from constitutional disease, and young also, if possible. In operating, the blood is usually thrown into the venous system of the receiver; but Hüter, of Greifswald, recommends that it be thrown into the arterial instead of the venous system, believing that it would thus pass into the heart in a more equable and less rapid manner. So, then, in cases where organic weakness of the receiver's heart, *e. g.*, fatty degeneration, is present, transfusing into the arteries, as advised by Hüter, would be preferable to transfusing into the veins.

The operation for immediate transfusion, described above, though simple, requires considerable skill and delicacy of manipulation; and those expecting to practise it, will do well to perform it a few times on animals, for then no difficulty will be experienced in operating on man. It proves most useful after profuse hemorrhage, where the vessels are comparatively empty and the vascular tension is but slight; in chronic cases, where the vessels have become filled again to about their natural capacity, the blood should be transfused in but small quantity at one sitting, that is about six ounces at a time, lest too great a strain be placed upon the heart. Throughout the whole procedure, great care must be taken against the entrance of air into the bloodvessels, for this accident might prove quickly fatal.

¹ Medical Record, April 15, 1874.

² Principles and Practice of Surgery, vol. i. p. 176.

Immediately after the operation of transfusion, a rigor often appears; but, in a short time, it passes away. Occasionally, syncope is threatened; but this sense of faintness, too, quickly vanishes. In cases which have been judiciously selected, and in which the operation has been dexterously performed, an improvement in the patient's condition is soon seen. The pallid lips assume a rosy hue, the pulse regains its volume, and the patient himself acquires a consciousness of returning strength.

Transfusion of Milk.—The intra-venous injection of milk is now recognized as a perfectly feasible and legitimate procedure, not only in cases of exhaustion from hemorrhage, but also in disorders which greatly impoverish the blood, such, for instance, as cholera, pernicious anæmia, typhoid fever, etc.; it is very much easier of performance than transfusion of blood, and any one at all familiar with surgical operations may practise it without fear of great difficulty or of failure. The instrument required is a glass funnel with a rubber pipe attached to its stem, and ending in a very small bent canula for insertion into a vein. The milk should be withdrawn from a healthy cow within a few minutes of its use; it may be received in a warm pitcher, covered with carbolized gauze, through which it is strained. The median basilic or median cephalic vein is to be opened by a V-shaped incision; then the canula is to be placed in the wound, and the milk allowed to flow through it into the vessel, not more than eight ounces being introduced at one time. Transfusion of milk, like transfusion of blood, is commonly followed by a chill, with rapid and marked increment of body-heat; this, however, soon subsides, and great improvement in the patient's condition at once appears.

WOUNDS OF ARTERIES.

In discussing the injuries of bloodvessels I shall first take up the wounds of arteries, because they have the most importance. The traumatic lesions to which the arteries are exposed naturally range themselves under the following heads:—

1. Punctured Wounds.
2. Contused Wounds.
3. Lacerated Wounds and Ruptures.
4. Gunshot Wounds.
5. Incised Wounds.

This classification, while quite devoid of arbitrariness, is very convenient for descriptive purposes, and equally useful for the student and practising surgeon. The wounds of each group are characterized by peculiarities in respect to their phenomena and consequences, which are of practical importance, and which, therefore, deserve special mention.

PUNCTURED WOUNDS OF ARTERIES.

These wounds, because of their comparative frequency, the difficult problems which their treatment sometimes presents, and their fatality, are of great interest and importance to surgeons. Maisonneuve has shown that an artery may be pierced by a delicate instrument, such as a fine needle, without producing hemorrhage, or any other unfavorable result. But if the vessel be pierced by a larger instrument, such as a tenaculum, disastrous consequences may follow. For example, Guthrie saw two cases in which the femoral artery was wounded by a tenaculum, and ulceration, followed by hemorrhage,

took place in both, requiring the application of ligatures.¹ Guthrie also thought that longitudinal fissures in the coats of arteries, one or two lines long, were not attended by bad consequences. But Deschamps's case shows that he was mistaken:—

In this case the brachial artery in the upper part of its course was opened by the point of a knife. The wounded man walked a little way; but, becoming weak from loss of blood, which was great, he fell to the ground insensible from syncope, and for a time the bleeding ceased. On the eighth day copious hemorrhage again occurred. On the ninth and tenth days small bleedings took place. On the morning of the eleventh day hemorrhage recurred to an alarming degree, the bed being soaked through with black and fetid blood. At noon the bleeding again returned with violence. The patient died, and, on opening the body, Deschamps found the brachial artery punctured in a longitudinal direction, at its external and posterior aspect, to the extent of two lines, opposite the inferior border of the tendon of the pectoralis major muscle, and above the origin of the superior profunda artery.²

In this case a traumatic aneurism resulted from the wound, for the relief of which several operative procedures were tried in vain, and the patient lost so much blood that, in the end, he lost his life thereby. Such were the consequences of a longitudinal puncture of the brachial artery, only two lines long. When the aperture is of greater size the risk is correspondingly increased, unless it is promptly averted by the surgeon's skill. When the puncture opens an artery obliquely or transversely to its course, it acquires a circular or rather a rounded shape, with consequent increase of size, from the action of muscular and elastic fibres in its walls, which are divided by the puncture. But the relation of a few examples will give more practical knowledge of this subject than many pages of general description:—

William Colles relates the following case: A laborer, aged fifty-six, was admitted to Stevens's Hospital, March 30, 1855. At dinner on the previous day he had swallowed a fish-bone, which, he stated, he felt cutting him very much at the time "in his chest," and this cutting pain was increased very much by the act of swallowing. Almost immediately he began to spit blood in large quantity, at first dark-colored, but soon bright-red. At twelve o'clock next day, when he entered the hospital, he complained of acute pain in his chest, and of great weakness. He had a blanched look and a hemorrhagic pulse. Immediately after admission he vomited a fish-bone, about one inch long, narrow and irregular in shape, with sharp points and cutting edges. He continued to vomit blood freely throughout the day, but not so freely as at first; the quantity gradually diminished until nine P. M., when he died. *Necroscopy.* The posterior mediastinum was filled with coagulated blood. The stomach contained a large clot, and the small intestines were also filled with coagula. There was found in the posterior wall of the œsophagus an oblong irregular opening, about half an inch in length, and extending from above downward; in the corresponding part of the aorta there was a longitudinal slit exactly opposite to that in the œsophagus, which differed only in being smaller and more irregular.³

In this case the swallowed bone stuck fast in the œsophagus; it cut quickly through the posterior wall of the gullet; and, being strongly impelled by the acts of swallowing, it pierced the front wall of the aorta, and caused traumatic hemorrhage, which speedily proved fatal. In this case, too, the punctured wound of the aorta was longitudinal, and scarcely more than three or four lines in extent; yet the hemorrhage was very profuse, and did not cease until it extinguished life.

¹ Diseases and Injuries of Arteries, p. 212.

² Observations on Aneurism, Sydenham Society's edition, pp. 406–409. London, 1844.

³ Dublin Quarterly Journal of Medical Science, 1855, vol. xix. pp. 325, 326.

Another instance of punctured wound of, and primary hemorrhage from, the thoracic aorta, which belongs to the same category as the last, was also observed in Ireland only a few years ago. A woman named Nolan, aged 47, an inmate of Richmond Lunatic Asylum, at Dublin, died very suddenly after vomiting blood. The autopsy and the evidence adduced by the coroner showed that she came to her death in consequence of hemorrhage from a punctured wound in the aorta, caused by a sewing-needle which she had swallowed. This needle had perforated the posterior wall of the œsophagus, and pierced the anterior wall of the aorta; a part of it was found still embedded in the œsophagus, and it was covered with rust.¹

This case as well as the last was not amenable to treatment, because the wounded artery was so placed in the body that it could not be exposed and tied by any surgical operation. Durham, however, relates a case in which the carotid artery bled from a punctured wound, extending to it from the pharynx, that was successfully treated by ligating the artery:—

A boy, aged 7, fell while holding the sharp end of a parasol in his mouth. The point came almost through the skin on the left side of his neck. Considerable hemorrhage occurred at once, and recurred at night. About the seventh or eighth day a slough came away by the mouth, followed by arterial hemorrhage to the amount of five ounces, which was stopped by pressure applied externally, when the boy was brought to St. George's Hospital. A swelling as large as the half of a hen's egg was found beneath the left ear, and the skin for some distance around was discolored, as from extravasated blood. The swelling fluctuated at the summit; it was opened, and pus with much blood-clot escaped, but no hemorrhage ensued. Two days later a gush of arterial blood followed a fit of coughing, and the common carotid artery was promptly cut down upon and tied by Mr. H. C. Johnson. Both wounds soon healed, and the boy made a good recovery.²

In the following instance of stab-wound of the neck, where the point of a knife punctured the internal carotid artery, the hemorrhage was checked by digital compression until the vessel could be tied on each side of the wound, and recovery followed:—

On July 31, 1869, a miller was wounded in the neck, at the angle of the lower jaw, by the large blade of a pocket-knife, which penetrated to the depth of several inches, and opened the internal carotid. Alarmed by the tremendous jets of arterial blood, Dr. J. M. Denning, in whose drug-store the stabbing occurred, immediately seized the man's neck, and compressed the carotids. Happening to be close at hand, Dr. A. T. Lee promptly cut down upon the artery by the usual incision, exposed it by careful dissection, found the bleeding point, and applied a ligature on the cardiac side of it.

The patient, who had fainted, now rallied, but severe arterial hemorrhage again occurred, the blood coming from above, through the circle of Willis, from the opposite carotid and the vertebrals. A ligature was then placed on the distal side of the wound in the artery, and the regurgitating hemorrhage at once ceased. The patient was now pulseless, and death was considered imminent; but under prompt and energetic stimulation with whiskey and ammonia, the circulation soon became good; respiration grew full and regular, and, fifteen minutes after the operation, speech returned. He was confined to bed five weeks, but made a good recovery ultimately, being still alive and actively employed over nine years afterward.³

This case answers several good purposes. It illustrates the plan of treatment which, when practicable, is best calculated to save patients having punctured wounds of arteries, namely, the exposure of the bleeding point in the artery by enlarging the original wound, or by making fresh incisions, as

¹ *Lancet*, 1877, vol. ii. p. 789.

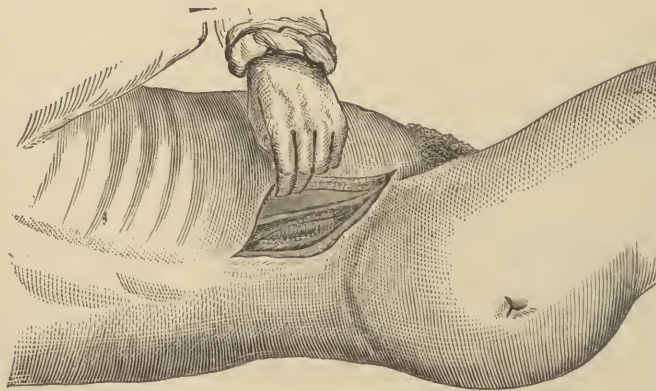
² *Holmes's System of Surgery*, vol. ii. p. 457.

³ *American Journal of the Medical Sciences*, January, 1879, pp. 142, 143.

required, and then applying two ligatures to the artery, one on each side of the aperture. It shows why cases treated with proximal ligatures only are liable to prove, and not unfrequently have proved, fatal from a return of hemorrhage, the blood regurgitating through the distal portion of a wounded artery tied proximally on the establishment of a collateral circulation. And, finally, this case is historically important, as being the first where the internal carotid artery has been successfully secured with two ligatures for traumatic hemorrhage.

The next case occurred in the person of a soldier during the war of the rebellion. He was accidentally wounded by a bayonet-thrust in the right buttock, at Milwaukee, March 18, 1864, and was returned to duty July 12. He entered University Hospital, New Orleans, August 29, and was furloughed September 19. He entered the Marine Hospital, Chicago, September 30, and died October 11. At the time of injury there was bleeding to the amount of fifteen ounces. The urine was drawn by catheter for four days, and contained much blood. Great swelling in the iliac fossa and right buttock occurred immediately. The patient was sent to his regiment in Arkansas, after two months, but he could hardly walk with the aid of a cane. He suffered from what he described as "hammering pain" in the tumor, which was observed to pulsate. Topical applications afforded no relief. When admitted to Chicago Hospital, he was suffering great pain in the tumor and right lower extremity. He was anemic and presented the constitutional symptoms attending great loss of blood. The tumor was red and glistening, and extended from the crest of the right ilium to the natal fold. The cicatrix of the bayonet-stab was nearly in its centre, and beside it was a puncture recently made for exploration by a surgeon on the transport steamer. The puncture was dilated to the size of a half-dollar and filled with coagula, through which, October 2, arterial blood escaped. There was numbness of the limb and dysuria. A bruit, but no audible pulsation, was found on auscultation. On October 2, an injection of perchloride of iron in solution was resorted to, with temporary arrest of hemorrhage, and injections were repeated on recurrence of the bleeding. It was decided to tie the common iliac.

Fig. 419.



Diagrammatic drawing of the incision in Isham's case of ligation of the right common iliac artery, for traumatic aneurism of the anterior trunk of the internal iliac artery, caused by a bayonet-wound. The bayonet-stab on the right buttock is also shown.

On October 7, the operation was performed by Dr. R. N. Isham, the patient being under chloroform. A curvilinear incision was made from in front of the extremity of the twelfth rib downward and forward to the crest of the ilium (Fig. 419), and along the crest, terminating near the anterior superior spinous process. The muscles and transversalis fascia were successively divided, and, the peritoncum being held out of the way by two fingers, the deep wound was enlarged to the extent of the external incision.

The peritoneum was lifted uninjured by the hand, together with the intestines, and the vessel was exposed to view, not a drop of blood obscuring the parts. The ureter was lifted with the peritoneum. A Mott's artery needle was passed under the vessel. The tightening of the ligatures not only arrested the circulation in the limb, but diminished the tumor, so that its tense surface became flaccid. The wound was closed; the limb was enveloped in cotton, and placed in an easy position; warm-water bottles were arranged near it; a half-grain of morphia was given, and oyster-broth. The patient had a good night, and the limb was of natural temperature. Pulse 113; a dose of four drops of tincture of veratrum viride was given at seven in the morning; at eight in the evening the pulse was 80. October 9, pulse 90; the discharge from the sac being offensive, the clots were turned out, and the sac was injected with a solution of the permanganate of potassium. October 10; discharge from sac very offensive. October 11; he died at 10 A.M.

The *autopsy* revealed no evidence of peritonitis. A well-organized clot extended from the seat of ligation to the aorta. The artery punctured was the anterior trunk of the internal iliac, within the sacro-ischiatic notch. The walls of the enormous sac were gangrenous. There was no appearance to account for the hamaturia. The account of the case and the drawing have been taken from the Medical and Surgical History of the War of the Rebellion, Second Surgical Volume, p. 335.

In this soldier's case, the successive steps in his downward course were as follows: (1) the bayonet-stab of his buttock opened the anterior trunk of the internal iliac artery; (2) the formation of a traumatic aneurism ensued; (3) from continued neglect, this aneurism attained an immense size, the sac suppurated, the blood in it putrefied, the constitutional signs of septicaemia were rapidly developed, and death speedily resulted. Dr. Isham was satisfied, after the autopsy, that the method he adopted was preferable to the "old operation," an opinion to which, however, Dr. Otis, the surgical historian of the war, does not subscribe. The fact is, this case, from commencement to close, presented some of the most difficult problems of surgery. Theoretically, the wounded artery should have been tied on each side of the aperture in its walls, as soon after the mishap as possible. But this operation could not have been performed through any incision made in the gluteal region. How, then, was the wounded part of the artery to be reached and exposed, and tied? It might have been done with certainty by opening the abdominal cavity, as in ovariectomy, and approaching the vessel through the pelvis; but the surgeon would be justified in pausing long and pondering much before undertaking this operative procedure, as he would, also, at an early stage of the case, with regard to ligation of the common iliac artery, inasmuch as that operation would offer but little hope of success in a part where communication by anastomosis among the terminal branches is so free.

But the policy of delay which was pursued in this man's case from March to October wrought no good. Moreover, the history shows very clearly that as time went by the chances of his recovery steadily diminished, and that without radical treatment of some sort his recovery was not at any time possible. These points are eminently practical, and cannot be too strongly impressed upon the attention of surgeons. The plan of treatment which appears to have been adopted at the outset of this case, and followed more than six months, was fatally defective, because it did not recognize the absolute necessity of closing the orifice in the wounded artery by the application of ligatures, or, in default thereof, by securing the formation of an organized blood-clot in the canal of the wounded artery.

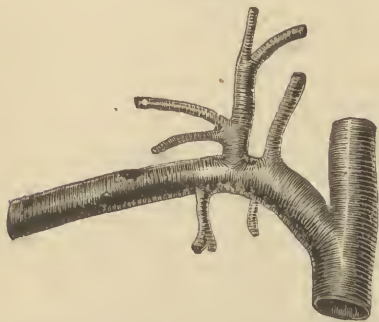
What, then, should the surgeon of to-day do when called on to treat a stab-wound of the buttock penetrating the pelvis, and opening the internal iliac artery, or one of its main branches? After staying the external bleeding, his thoughts should at once be directed to stopping the internal bleeding also. If necessary to a more exact diagnosis, he should explore the pelvic

cavity with his hand introduced into the rectum, as practised by Sands in analogous cases.¹ But, before doing even this, he should try the effect of compressing the common iliac artery, on the same side as the wound, with his fingers, firmly, against the last lumbar vertebra or the brim of the pelvis. If in this way the bleeding were controlled, as in most cases it probably would be, as indicated by diminished tension and swelling, with disappearance of pulsation in the tumor, he should direct the compression to be continued digitally, or by a suitable tourniquet, or by Esmarch's elastic bandage, applied in some of the ways already described, until the blood had coagulated in the tumor itself and in the canal of the wounded artery. He should most earnestly strive to obliterate the wounded artery by compressing the common iliac, or, if that were impracticable, by compressing the adjoining aorta; for he could not ligate the bleeding artery in the external wound; it would not be justifiable to reach it by opening the belly as in ovariectomy; and the operation of tying the common iliac, on the plan of Hunter, would be far too serious and uncertain of result to be resorted to at the outset.

Again, the arteries are sometimes pierced from within the body by sharp fragments of bones that have been broken by the impact of gunshot projectiles, as happened in the following instance:—

A soldier² was admitted to hospital September 20, 1864, with a gunshot wound of the right side of his neck, received on the previous day. He was very weak from hemorrhage from the wound and from hæmoptysis. Notwithstanding plugging of the wound, etc., the hemorrhage and the hæmoptysis continued, and on October 5, death resulted. *Necropsy.* A conoidal musket-ball had entered the right inferior triangle of the neck, fracturing obliquely the first rib at its middle, and depressing the sternal

Fig. 420.



Perforation of the right subclavian artery by a sharp fragment of the adjoining first rib, fractured by gunshot. (Spec. 3377, sect. 1, A. M. M.)

Fig. 421.



First rib fractured obliquely by gunshot; a fragment perforated the right subclavian artery. (Spec. 3376, sect. 1, A. M. M.)

portion thereof into the apex of the right lung; the other fragment stuck upward with a sharp-pointed end, which perforated the subclavian artery in the second part of its course. The missile emerged from the back above the spine of the scapula. The mediastinum and the right pleural cavity were filled with extravasated blood. The right intercostal spaces bulged outward. The heart was pushed toward the left. The right lung was collapsed. There were marks of periostitis on both portions of the rib. The appearance of the artery, well represented in Fig. 420, indicated that the laceration of its walls had occurred either at the time of impact of the missile, or from some sudden movement of the shoulder, rather than from gradual attrition. The broken rib is drawn half size in the accompanying illustration (Fig. 421).

¹ American Journal of the Medical Sciences, April, 1881, pp. 366-373.

² Medical and Surgical History of the War of the Rebellion, First Surgical Volume, p. 521.

But minute missiles discharged by fire-arms, such as bird or squirrel shot, may themselves inflict on large arteries minute lesions which closely resemble, if they are not identical with, punctured wounds. The following example occurred in the practice of Prof. S. D. Gross :—

A strumous lad, aged 14, was wounded in the neck by the accidental discharge of a fowling-piece, loaded with large-sized squirrel-shot, which entered the neck at four or five different points. The casualty was attended with but little hemorrhage, and the symptoms of shock soon passed away. The wounds healed without any application, and everything went well until thirteen days after the accident, when the patient was seized, suddenly and without warning, by a protracted epileptic convulsion, affecting chiefly the left side, and died the following day, without return of consciousness. *Autopsy.* One shot had perforated the subclavian artery, and had lodged in the first rib. The calibre of the vessel was unimpaired, and the apertures were closed by small clots extending around the exterior of the vessel, upon the removal of which the margins of the wounds appeared as if they had just been inflicted. The artery presented no marks of inflammation.

Another shot had perforated the anterior wall of the right internal jugular vein, and had lodged on the inner surface of the opposite wall, where it had become completely encysted. The vein bore no evidence of inflammation. The opening in the anterior wall was perfectly closed, and there was no external nor internal clot. The lumen of the vein, however, was somewhat diminished by the projecting cyst.¹

It is of interest to observe that, in this case, the shot-hole in the great jugular vein was found, after the lapse of fourteen days, perfectly closed or healed without the aid of blood-clot, and without inflammatory engorgement. This wound had therefore united by the first intention, as usually happens after venesection.

The minute apertures in the subclavian artery were closed by small clots extending around the exterior of the vessel, without invading its canal. J. L. Petit long since pointed out that in such cases clots form which fill the apertures in the wall of the artery, and exactly close them, without encroaching upon the canal of the artery. He says these clots are shaped like nails, the points of which equal in length the thickness of the arterial wall, while their extremities, which correspond to the moving column of blood, are worn off by the friction they undergo. Their heads, which correspond to the exterior part of the artery, are very broad; they contract adhesions with the external surface of the artery and the adjacent cellular tissue. These adhesions become stronger, and when they are well cemented the artery is healed, and the clots cannot be displaced by the impulse of the blood which continues to pass through the artery, as before the injury. Exactly such as Petit describes, were the small clots found in the case just related, closing the minute shot-holes or punctures in the subclavian artery. Had the boy lived, it is highly probable that these clots would soon have become fully organized, and thus have effectually sealed the minute punctures with newly formed tissue. Hodgson, also, remarks that when an artery is punctured the hemorrhage is sometimes arrested by the formation of a thin layer of coagulum over the orifice in the vessel, and that the edges of the wounded artery are subsequently united by an effusion of lymph, in the same manner as wounds in soft parts in general are healed by adhesive inflammation. This mode of reparation, by which the continuity of the tube is preserved, takes place more readily when an artery is wounded longitudinally, as well as to but small extent, than when the wound is transverse or oblique; for in the latter cases the retraction of the artery causes the orifice in its wall to assume a circular form, in consequence of which the effusion of lymph is greater than

¹ American Journal of the Medical Sciences, January, 1867, pp. 41, 42.

when the edges of the wound are more closely approximated, or placed in contact. It is, then, by the organization of blood-clot and the effusion of coagulable lymph that minute lateral wounds of arteries may become closed without obstructing their canals: and, doubtless, those rare instances on record in which the aorta and other large arteries have been punctured without any permanently bad consequences, were of this character, and were healed in this manner.

It must be admitted, however, that such instances of perfect cure of punctured wounds of arteries are quite exceptional and rarely to be expected. And when we consider that most persons who have had an artery pricked, and who have been treated by compression, have also had a false aneurism, we cannot help thinking that their cure has been only apparent. In this way circumscribed traumatic aneurisms appear after puncturing the brachial artery in venesection, when compression is used; the patient is thought to be cured, and the surgeon feels safe; but in three or four months, sometimes later, the clot by which nature has arrested the hemorrhage, becomes detached, or the newly formed tissue by which the aperture was closed, yields to the pressure of the blood, and an aneurismal swelling forms.

CAUSES.—Punctured wounds of arteries may be inflicted with the sharp points of scissors, as happened in a case reported by Deschamps, where the femoral artery was pierced in this way; with penknife-blades, as in several cases which have been reported; with lancets, in bleeding at the elbow, as has often happened in both ancient and modern times; with pocket-knives, many instances of which accident have been recorded; and, finally, with daggers, swords, bayonets, or any other narrow-bladed weapons. Arteries may also be fatally pierced by sharp fragments of bone, and by sewing-needles, when swallowed. Arteries may be punctured by sharp fragments of necrosed bone, as happened some years ago in New York, in a case where the popliteal artery was pierced by the point of a femoral sequestrum, and with a fatal result. Again, punctured wounds of arteries may be caused by fragments of bones that have been broken by the impact of gunshot projectiles; they may also occur in comminuted fractures, simple as well as compound, that have been produced by other means. Puncturing of arteries from fragments of broken bone is believed to occur in the leg more frequently than in any other region, and this view is supported by Dupuytren's published cases. Arteries, too, may be punctured by sharpened sticks, or by splinters of wood.

SYMPTOMS.—Punctured wounds present nearly the same phenomena as those made by cutting instruments; there is always bleeding, to a greater or less degree; but the pain is frequently much more severe, since the instrument often tears the parts. Hemorrhage takes place when the puncturing instrument has met in its course an artery of some size, and pierced or divided it; in either case, blood escapes externally, when the wounded artery is superficial, and the wound itself has been made perpendicularly to the skin; but when the puncturing instrument has passed very obliquely into the part before reaching the artery, the blood infiltrates into the connective tissue and produces a diffuse traumatic aneurism, unless the escape of blood from the artery be quickly stopped, by compressing the artery itself at the wound, or by compressing the main trunk above, that is, on the cardiac side of the wound, through the soft parts by which it is covered. In the latter case, there may quickly be formed at the aperture in the artery a clot of blood, which prevents further hemorrhage; but if the compression be not properly made, or if it be not sufficiently strong, or if it be not continued long enough to

obliterate the injured vessel, the clot soon becomes detached, and the escaping blood forms a circumscribed traumatic aneurism. In all cases of diffuse traumatic aneurism, and in many cases of circumscribed traumatic aneurism, there is actually traumatic hemorrhage going on unchecked, but the bleeding is internal and concealed from view instead of being external and exposed to sight. When the aorta is pierced by a sewing-needle or by a sharp fragment of bone that has been swallowed, the discharge of arterial blood from the mouth by vomiting is always a prominent symptom.

CONSEQUENCES.—Punctured wounds involving arteries may be attended with the complications or consecutive phenomena which are common to punctured wounds in general, such as phlogosis, with acute pain and severe irritation, etc. Moreover, they are very fatal. Of the illustrative examples given above, six ended in death and only four in recovery. Of eleven stab-wounds involving the vertebral artery, collected by Kocher, only two terminated favorably. Punctured wounds of the femoral and axillary arteries are of not unfrequent occurrence, and often prove fatal. The first bleeding may end in death; or, if it be inadequately treated, it may recur again and again, until it wears out and finally kills the patient by exhaustion. Again, if the blood continue to escape from an artery into the connective tissue while the external wound is closed, in the primary period, there occurs a diffuse traumatic aneurism, which is only another name for primary arterial hemorrhage taking place internally. If such an inward bleeding occur in the fore part of the neck, the resultant swelling may so compress the larynx and trachea as to cause death by suffocation. If it occur in the loose connective tissue of the armpit or thigh, the extravasated blood may burrow very widely as well as cause great tumefaction, from which there may result a suppurative inflammation of the infiltrated connective tissue, with putrefactive changes in the effused blood, followed by septicæmia and death.

Diffuse traumatic aneurisms are very liable to follow punctured wounds of arteries, and must be reckoned among the most important of their consequences. They will be fully discussed in the section on Traumatic Aneurism.

Arterio-venous aneurisms sometimes follow punctured wounds which simultaneously involve arteries and their contiguous veins. They occur most frequently at the bend of the elbow from mistakes in bloodletting; but they have also been met with in the neck, thigh, and other regions. They will be fully discussed in the section on Aneurismal Varix and Varicose Aneurism.

Punctured wounds of arteries, when very minute, and not attended with much primary bleeding, are occasionally followed by severe secondary hemorrhage, from ulceration of the artery at the place of injury, as happened in three instances (two related by Guthrie and one by Durham) that are mentioned above. There is also a specimen in our Army Medical Museum which illustrates a similar occurrence. It consists of a popliteal artery, from which secondary hemorrhage took place eleven days after it was punctured by a spiculum of bone. The femur was obliquely fractured by a pistol ball, in its lower third, with slight comminution. The artery did not bleed until its coats sloughed at the place of puncture. The hemorrhage was then arrested by tying the femoral, but traumatic gangrene of the limb supervened, and death occurred three days after the operation.¹

TREATMENT.—The course which is most likely to avert the disastrous consequences just enumerated, consists of promptly exposing the wounded artery at the place of injury by suitable incisions, and applying two ligatures to it,

¹ See Catalogue of the Army Medical Museum, Specimens 4084, 4085.

one on each side of the bleeding orifice, as recommended by the ancient surgeons. But before this operation can be performed it is often advisable to restrain the bleeding by compressing the wounded orifice and main trunk of the injured artery, with the fingers, or with a suitable tourniquet, or with Esmarch's elastic bandage, according to methods which have already been described, whether the blood be escaping through an external wound or infiltrating the connective tissue around the artery. With regard to the employment of compression for punctured wounds of arteries, the rule is to consider it a temporary expedient, since it often procures only transient relief, and leaves the patient exposed to false consecutive aneurism. There are, however, some important exceptions to this rule, which will presently be mentioned. A ligature should be applied on the distal as well as on the proximal side of the aperture, because, unless this be done, the hemorrhage is liable to occur again, as soon as the parts beyond the wound become well supplied with blood through the anastomosing branches or collateral channels. The blood then regurgitates in the distal part of the artery, and is very liable to force its way through the distal orifice, unless the artery is here also closed with a ligature. The artery should moreover be divided midway between the two ligatures, so that both ends can freely retract.

PUNCTURED WOUNDS OF SPECIAL ARTERIES.—*Vertebral Arteries*.—We pass now to the consideration of some points in the treatment of punctured wounds of arteries which are surrounded with great difficulties. No single point, perhaps, is more puzzling than to devise a satisfactory plan of treating wounds of the *vertebral artery*. Almost all the recorded cases, and their number is not small, have proved fatal. This vessel lies so deep, and the diagnosis of its lesions is so difficult, that in eleven instances of traumatic aneurism involving it, the carotid has been tied through mistake. The explanation is that when the carotid is compressed against the so-called carotid tubercle of Chassaignac, on the transverse process of the sixth cervical vertebra, the vertebral artery also is compressed, at its point of entry into the foramen of the transverse process. The deception is not removed by compressing the carotid at a higher point, for the vertebral may pass up the front of the transverse processes. In recent wounds, the best way to ascertain the vessel from which the blood issues, is to insert into the wound a finger, with which the jets of arterial blood may generally be felt, and the relation of the wounded vessel and of the hemorrhage to the transverse processes of the vertebræ determined. Ligature of the vertebral artery for practical purposes is impossible except in a portion about six centimetres, or two and three-eighths inches, long, between its origin and its entrance into the transverse foramen of the sixth cervical vertebra. In this part of its course it has been successfully tied by Smyth, of New Orleans, for regurgitating hemorrhage; in this part, also, it has been tied, together with the inferior thyroid artery, by Maisonneuve, in order to arrest hemorrhage attending a shot wound of the neck—with success, as far as stopping the hemorrhage and extracting the ball were concerned, though death occurred from infiltration of pus into the spinal canal, and consequent inflammation. But these successes, complete and partial, afford some encouragement. Having determined by exploring the wound with a finger, or by any other means, that the vertebral artery is punctured in this part of its course, the bleeding point should at once be laid bare, and a ligature should be put round the artery on each side of the aperture. But when the exploration shows that the artery is wounded above the point where it enters the foramen of the transverse process of the sixth cervical vertebra, how can we suppress the bleeding and save the patient? We cannot tie the artery in the wound; and to tie it in the first part of its course,

on Anel's plan, would fail, because the two vertebrals unite to form the basilar artery at the base of the brain, and therefore regurgitating hemorrhage would occur in the wound whenever the direct hemorrhage might be stopped in this way. Distal ligation of this artery, between the occipital bone and the atlas, as suggested by Dietrich, would be both difficult in performance and uncertain in result. There remains, then, only the operation of plugging the wounded artery, a measure which has been successfully employed in one case by Dr. Kocher, of Bern.

On dilating the wound in the neck by suitable incisions both longitudinal and transverse, and removing the coagula, the blood was seen to come from a point between the transverse processes of two vertebræ, apparently the fifth and sixth. Arterial blood escaped from both the central and the peripheral portions of the artery; and the bleeding was arrested by pressure against the transverse processes, either from above or from below. As a ligature could not be applied, a plug of charpie of the size of a pea, soaked in solution of perchloride of iron, was introduced between the transverse processes, and left there, as soon as it had been ascertained that the bleeding was suppressed. The external wound having been closed by sutures, was covered with charpie dipped in carbolic glycerine, Lister's carbolic-acid paste was applied, and the dressing was retained in place by a bandage. The head was kept fixed by a stiff collar. The plug in the deep part of the wound was removed on the fourth day after the operation, partly by means of a stream of water, partly by forceps; no bleeding followed. Excepting a slight attack of erysipelas, the patient progressed steadily toward recovery, and was discharged cured a little more than five weeks after the operation.¹

But in order to secure the success of this operation of plugging the vertebral artery, it is essential that the bleeding point in the vessel shall be exposed to view, that the plug shall be placed exactly in the open canal of the vessel, which it must completely fill, and that the patient's head shall be held fixed, and the neck immovable, by a stiff collar. False consecutive aneurisms of the vertebral artery are not unfrequently met with; they will be discussed in the section devoted to the subject of Traumatic Aneurism.

Carotid Artery.—Punctured wounds involving the *common carotid* artery, or its branches, are often met with, owing to the exposed situation of the parts supplied with blood by the carotid system of vessels; and, from the comparative ease of performing the operation, ligation of the common trunk for suppressing hemorrhage from these wounds, has probably been resorted to much more frequently than has been desirable. In instances too numerous to mention, the common carotid artery has been tied for lesions of its branches, without success, when the result would have been quite different had the wounded artery itself been properly secured. It is therefore imperative, when branches of the *external carotid*, for instance, are opened by wounds, that they should be tied at their wounded part with ligatures placed on each side; and, in cases where the performance of this operation, as well as ligation of the trunk of the wounded vessel itself, is impracticable, it is equally imperative that the external carotid should be tied, and not the parent trunk of all. In two instances, Stephen Smith ligatured the external and internal carotid arteries, just above the bifurcation of the common carotid, for hemorrhage from various points of the face and neck, and into the mouth and fauces; in one case it was for cancer, and in the other for gunshot injury. He thought thus to avoid renewal of the bleeding better than by ligation of the common trunk. In neither case was there any return of the bleeding, the ligatures separated well, and the patients recovered.² Again, in cases of hemorrhage from branches of the external carotid, such as the lingual, inter-

¹ Sydenham Society's Biennial Retrospect, 1871-2, p. 203.

² American Journal of the Medical Sciences, April, 1874.

nal maxillary, etc., when ligation of the corresponding external carotid fails to stop the bleeding, the external carotid on the opposite side should also be tied, and not the common trunk; for ligation on both sides of the external carotid artery has hitherto, I believe, been uniformly successful in subduing such hemorrhages.

In wounds involving the trunk of the *common carotid*, or that of the *internal carotid*, or that of the *external carotid*, the hemorrhage should be stayed, if possible, by digital compression applied in the wound or to the trunk of the common carotid, in the ways already pointed out, until a surgeon can be brought, and ligatures placed on each side of the orifice in the wounded vessel. Moreover, the application of distal ligatures is especially necessary in wounds of the carotids, as well as in those of the vertebrae, because of the remarkably free intercommunication which exists at their terminal extremities, through the circle of Willis. In connection with the treatment of hemorrhage from a lesion of the *internal carotid artery*, read the successful case of the miller quoted on page 562.

Occipital, Temporal, and Facial Arteries.—When the *occipital artery*, or the *temporal*, or the *facial*, or any other accessible branch of the external carotid is opened by a punctured wound, we repeat, the bleeding must be restrained by firmly compressing the primitive carotid artery against the transverse processes of the vertebrae (Fig. 346, p. 518); the injured part of the artery must be laid bare by incisions, and the bleeding orifice must be distinctly brought into view; a ligature must be applied on each side of the orifice, and the artery itself must be completely divided midway between the two ligatures, to allow the ends to retract. But if the injured part of the artery cannot be thus exposed and ligated, a ligature should be applied to the injured artery on the cardiac side of the wound, as near to it as practicable. If this cannot be done, the external carotid artery should be tied, but not the common carotid. Should the hemorrhage still continue, the external carotid artery of the opposite side should also be tied; this procedure is said never to fail, as already stated above.

Axillary Artery.—Punctured wounds which open the *axillary artery* are also very liable to be quickly followed by death from hemorrhage; and the internal or subtegumentary bleeding may be, and often has been, but little less deadly than the outward bleeding. Here, too, for saving the patient, our chief reliance must be placed on adequate compression, promptly applied, either with fingers in the wound, directly on the aperture in the vessel, or with both thumbs upon the subclavian artery as it passes over the first rib, or with a large door-key, or the thumb-piece of a Petit's tourniquet, suitably covered by bandaging, in order to restrain the escape of blood from the artery, internally or hiddenly as well as externally or openly, until surgical aid can be obtained, and until the vessel can be tied where it is wounded. But, in most cases, to be successful, the pressure must be applied intelligently, energetically, and steadily, as well as promptly, and with a strong desire to prevent the formation of a sanguineous tumor in the loose connective tissue of this region, as well as to restrain the outward flow of blood. The formation of a large, diffuse, traumatic aneurism in this region, is to be deprecated almost as much as an unobstructed external hemorrhage.

Brachial Artery.—Punctured wounds which involve the *brachial artery* should always be treated on the orthodox plan of ligating it above and below the wound as soon as possible, the hemorrhage meanwhile being restrained by compression, which, in this region, can readily be applied. Old soldiers have not unfrequently done it well for comrades with tourniquets extemporized from handkerchiefs. On laying the bleeding point in the artery bare for the purpose of securing it with ligatures, a stream of blood is

sometimes distinctly seen by the surgeon, issuing from the distal orifice after the proximal ligature has been tied (regurgitating hemorrhage), which already shows the necessity of applying distal as well as proximal ligatures in these wounds. A soldier, aged 23, was accidentally wounded August 18, 1864, by a bayonet-thrust at the bend of the elbow, cutting the brachial artery. The vessel was tied on each side of the wound, and the man recovered. All the patients treated in this way did well. Not so, however, with some who were treated on other plans; for Dr. Otis, the surgical historiographer of the war, says: "There were one or two cases in which the reports convey intimations that stabs in the arm, implicating the brachial artery, proved fatal from malpractice—compression and styptics having been resorted to instead of ligation."¹

The following example, in which the *brachial artery* was punctured in the bend of the elbow with a penknife, will usefully illustrate what the treatment must be in order to prove successful: A good deal of blood was lost at the time, pouring out in a stream, not in jets, for the wound was an indirect one, the knife having entered obliquely. The patient was taken home, and the wound was strapped and bandaged; this arrested the hemorrhage temporarily. But the bleeding recurred several times, until finally the original wound was enlarged by incisions, the coagula were turned out, a traumatic aneurism that was forming was laid open, and ligatures were passed around the artery above and below the wound. Recovery followed without any difficulty whatever.²

Arteries of the Forearm.—Punctured wounds of the *radial*, *ulnar*, and *interosseous arteries* or their branches, and the hemorrhage resulting therefrom, in recent cases where the parts are sound, will give the surgeon but little trouble, provided he treats them on the orthodox plan of bringing distinctly the bleeding orifice into view, applying a ligature on each side of it, and dividing the artery midway between the two ligatures, so that the ends may retract. But if the surgeon should rely on styptics and compression in such cases, he will have much trouble which could readily have been avoided by ligating the injured vessels at the outset, above and below their wounds.³

Palmar Arch.—Punctured wounds of the *palmar arch* always excite apprehension, and give much trouble to the surgeon. Considerable differences exist among the plans of treatment recommended by eminent surgeons for this form of injury. Bryant points out that "extreme flexion of the forearm upon the arm, with forced supination of the hand, with or without a pad at the bend of the arm," arrests completely the circulation through the brachial artery; and that "under all circumstances, whether for injury or disease of the arteries of the hand and forearm, in which surgical interference is requisite, it would be well to remember this treatment, it being most effective."⁴ Many favor compression. The readiness with which it can be applied to the hand predisposes strongly to its use. This mode of treatment, however, is not a good one—is not to be commended, for it very often fails. Every surgeon has seen examples of such a failure. The medical journals contain reports of many cases in which compression proved to be insufficient to control the hemorrhage from punctured or incised wounds of the palm, and ligation of the radial and ulnar arteries, and of the brachial artery, as well as other operative procedures, were resorted to in order to remedy this insufficiency. Compression is but ill adapted to restrain hemorrhage from wounds involving the palmar arches, because of the wonderful flexibility of the hand itself, and

¹ Medical and Surgical History of the War of the Rebellion, Second Surgical Volume, p. 437.

² British Medical Journal, May 29, 1869, p. 492; see also the section on Incised Wounds of the Brachial Artery.

³ See also under Incised Wounds.

⁴ Manual for the Practice of Surgery, p. 350, second Am. ed.

the great freedom of communication which exists among the terminal branches of the arteries in the hand through the medium of large anastomoses. Some of the conditions most essential to success with compression, are quite wanting in the hand and wrist. Moreover, it is the treatment by compression that has furnished those instances, by no means rare, in which the patient has become pale and weak, or exhausted, from frequently recurring hemorrhages from wounds of the palm, and in which the wounded part itself has become infiltrated and boggy, and too much swollen and discolored to permit the injured artery to be laid bare and securely tied in the wound, without a great deal of difficulty.

Wounds of the palmar arch or of its branches form no exception to the general law that wounded arteries must be secured by ligatures applied on each side of the lesion, and that in case the artery is not severed by the accident, it must be divided by the surgeon midway between the two ligatures, so that retraction of the ends may take place. In all cases of surgical hemorrhage from wounds of the palm, the wound itself must be explored at the outset, and the source of the bleeding at once ascertained. While doing this it must be considered that between the palmar arches and the radial, ulnar, and interosseous arteries, a free intercommunication of branches exists, which branches are singularly uniform in their size; and that, in consequence, the distal part of the injured vessel may be almost as much inclined to bleed as the proximal. When the opening in the skin or the aponeurosis is not large enough to allow free access to the bleeding orifice, it must be enlarged to the required extent. In making incisions for this purpose, all thrusts with the bistoury must be avoided. The surgeon must understand and call to mind the arrangement and distribution of the vessels, and with such a knowledge he may proceed with entire confidence to lay bare the deep part of the hand. The skin must first be divided, and next the superficial fascia, when the palmar aponeurosis will be brought into view, and can readily be recognized by its white, tendinous appearance. The important vessels all lie beneath this structure. To open this dense membrane with safety, a slight perforation should be made through its substance, and a grooved director introduced, by means of which this aponeurosis can be raised up from the bloodvessels and nerves underneath, and its division successfully accomplished, thus giving an exposure of the parts sufficiently large for bringing into view and for successfully tying any vessel that may be wounded therein, according to the precept stated above. Dr. Ogston, in a difficult case, where the deep palmar arch was punctured by a knife-blade, succeeded in exposing the aperture in the artery to view by detaching the origin of the abductor indicis from the metacarpal bone of the index finger—that is, from the outer side of that bone. Then the artery was readily tied above and below the lesion. The patient made a good recovery.¹ Esmarch's apparatus for elastic compression was applied to the limb in this case, so that the operation was completed without loss of blood; and, in similar cases, it is generally advisable to prevent hemorrhage by the same method.

After ligating the palmar arch or its branches, and especially when the tissues are infiltrated and boggy or unsound, the force of the circulation in the hand should be lessened by keeping it in an elevated position, and by applying pressure to the radial and ulnar arteries by means of oblong compresses (Fig. 351, p. 521) placed on the forearm, and secured by a roller, beginning at the hand, and extending up to the elbow.

How should the neglected cases of wounds involving the palmar arch—those in which anæmic exhaustion from frequently recurring hemorrhages

¹ British Medical Journal, January 24, 1876, p. 782.

has ensued, and the tissues in the wounded palm are infiltrated and boggy, swollen, and discolored—How should such cases be treated? For them also the plan of treatment should be the same. The wound must be explored; the injured artery must be brought into view, and secured with ligatures in the wound. My own views coincide with those of Mr. C. D. Arnott, when he says: “The principle I wish to inculcate is that, under no circumstances, in hemorrhage from the palm, is deligation of the arterial trunks on the cardiac aspect to be deemed necessary or attempted. I am aware that this will at present hardly find general favor. I am, however, certain of my fact, and therefore state it boldly.”¹

Femoral Artery and Branches.—Punctured wounds of the thigh which open the common trunk of the *femoral artery*, or the *superficial femoral*, or the *profunda femoris*, however slight the puncturing of the artery may be, are very dangerous, and sometimes they are also very difficult to treat. A great many patients have been destroyed by these wounds. The main point in the treatment, however, is to restrain the primary hemorrhage, internally or at the orifice of the wound in the artery, as well as externally or at the orifice of the wound in the skin, without any delay, and without any temporizing with useless expedients. The formation of a diffuse aneurism in the femoral region is to be deprecated about as much as in the axillary region. In treating punctured wounds of the femoral artery, the bleeding should be restrained, both internally and externally, by exploring the wound with a finger, and placing the end of it upon the aperture in the artery; or by applying the elastic compression of Esmarch to the limb both above and below the wound; or by applying tourniquets or handkerchiefs tightly round the thigh above and below the wound, and thus controlling the circulation until the bleeding aperture in the artery can be laid bare by enlarging the wound, and until a ligature of carbolized catgut can be placed on each side of the aperture, and the artery itself be completely divided midway between the two ligatures to allow the ends to retract. Compression, although it is indispensable in such cases, must be looked on as a temporary expedient; as merely a very efficient means of preventing such a loss of blood as would prove fatal, or of keeping the patient in a salvable condition until the wounded artery can be properly secured by ligatures. The following case shows in a most excellent manner how punctured wounds of the femoral artery can be successfully managed:—

The subject was a young man, who, while mending a pen, accidentally let the knife penetrate his thigh at the middle. Free hemorrhage followed, which, however, was temporarily controlled by a handkerchief tied tightly round the limb. Mr. Maunder, on arriving, proceeded to search for the wounded vessel. He passed a finger readily into the wound to the depth of two inches, and felt the hole in a vessel which proved to be the superficial femoral artery. The finger being retained on this hole, the wound was enlarged upward and downward until the aperture in the artery was distinctly seen, and then a ligature was applied both above and below it. Venous-looking blood was observed to flow from the distal part of the artery. No discomfort attended the ligatures, which came away on the twelfth and thirteenth days respectively. The man made an excellent recovery.²

Here is another case in point: Mr. Messiter showed a patient who, in consequence of a punctured wound of the femoral artery, had acquired a diffuse traumatic aneurism. Mr. Houghton, three weeks after the accident, cut down upon the artery, and tied it above and below the wound. The patient made a good recovery.³

¹ Lancet, vol. ii., 1855, p. 141. See also observations on Incised Wounds of the Palmar Arches.

² British Medical Journal, November 23, 1867, p. 474.

³ Ibid., March 2, 1878, p. 302. See also section on Incised Wounds of the Femoral Artery.

In punctured and in incised wounds of the thigh where apparently the femoral artery is involved, it may be found on enlarging the wound that a large branch is pierced or cut, and not the femoral artery itself. In the following example, the *internal circumflex* branch of the profunda femoris was the seat of the lesion:—

Private John Davis, Co. C, 41st Infantry, aged 22, received on March 13, 1869, at Fort Clark, Texas, a punctured wound of the thigh. He was admitted to the post hospital, where the wound was enlarged, and the internal circumflex artery was ligated, under ether. Five days later, the ligature was removed, and the wound was filling with healthy granulations. On May 12, he was returned to duty.¹

In this case the injured artery was tied without delay in the wound; the patient rapidly and completely recovered. But had a policy of delay been adopted, or had styptics and compression been employed to control the bleeding, a diffuse aneurism would have ensued among the deep muscles on the inner side of the thigh, and the consequences would have been extremely disastrous.

Popliteal Artery.—Punctured wounds of the *popliteal artery* have been caused by the sharp ends of sequestra, by the sharp points of fracture splinters, by sharp slivers of wood, and by the points of bayonets, dirks, and other like weapons. These wounds have been treated by tying the artery above and below the aperture, according to the method of the ancient surgeons, by tying the femoral artery on the plan of Hunter, and by cutting off the leg. No one of these procedures will suit all cases. When gangrene is present or imminent, and, by the way, gangrene frequently ensues after this lesion, amputation performed without any delay is our sole resource. For hemorrhage, whether primary or secondary, the artery must be tied above and below in the wound. In some cases of traumatic aneurism resulting from a punctured wound of the popliteal artery, where there is a tolerably well-defined sac, it may be advisable to ligate the femoral artery on Hunter's plan, as being less likely to be followed by gangrene than the "old operation." Each case, however, must be critically examined, and that procedure must be applied to it which appears most likely to save the patient's life.²

Tibial Arteries.—Punctured wounds of the *posterior tibial artery* are occasionally met with; an example of this lesion was reported during the Crimean war, occurring in the person of a color sergeant belonging to the 18th regiment, who had been accidentally struck in the leg by the bayonet of one of the men, and whose posterior tibial artery was wounded. The case, however, presented no peculiarities. The wound was enlarged, the bleeding aperture in the artery was brought distinctly into view, and a ligature was applied on each side of it. The man recovered.³ In such cases the artery should also be divided midway between the two ligatures. In many cases where the posterior tibial or the anterior tibial artery is punctured, the performance of the old operation for ligating the injured artery in the wound, can be facilitated by applying the elastic compression of Esmarch to the leg above and below the wound in such a way as to effectually control the circulation.⁴

Plantar Arch.—Hemorrhage from punctured wounds of the plantar arch must be treated on the same plan as hemorrhage from punctured wounds of the palmar arch, which have just been fully discussed.

¹ Circular No. 3, War Department, S. G. O., August 17th, 1871, p. 242.

² See also Incised Wounds of the Popliteal Artery.

³ Surgical History of the British Army in the Crimean War, etc., vol. ii. p. 366.

⁴ See observations on Incised Wounds of the Tibial Arteries, and of the Arteries of the Foot and Leg.

Gluteal and Sciatic Arteries.—Punctured wounds of the *gluteal region* often prove very troublesome and unsatisfactory in their management, because they pierce the *gluteal* or *ischiatric* arteries far down beneath the gluteal muscles, or penetrate the cavity of the pelvis through its notches or foramina, and open the internal iliac artery itself, or one or more of its four or five important branches, within the pelvis. In such cases the surgical diagnosis is always difficult, and often impossible. In such cases, whenever practicable, the wound should be explored by introducing a finger into it for the purpose of locating by the sense of touch the precise point whence the blood issues by jets into the wound. If the punctured artery is found to be external to the pelvis, the bleeding point in it should be laid bare by enlarging and cleansing the wound, and the vessel should be secured by ligatures placed on each side of the aperture. But if it be shown by the occurrence of intra-pelvic extravasation of blood, or by other signs, that the internal iliac artery, or some branch thereof, is wounded within the pelvis, it will be impossible to reach and tie the punctured artery in the wound. Under these circumstances, it sometimes becomes very difficult to decide what plan of treatment should be adopted. One thing, however, ought never to be done: the solution of the perchloride or the persulphate of iron must never be injected into the track of the wound through the gluteal muscles, in order to restrain the bleeding in such cases, because the internal bleeding from the wounded internal iliac artery or branch thereof cannot be restrained thereby, and the presence of these salts of iron in wounds generally does much harm. Under these circumstances, the first thing to be tried, in most cases, is compression. It should be applied to the common iliac artery, and, at the same time, to the wound itself, if possible, with a view to obtain coagulation of the blood in, and obliteration of, the wounded artery. The very *desperateness* of these cases makes it all the more necessary to use the compression faithfully, intelligently, and persistently; otherwise, a traumatic aneurism will form. If we are successful in applying pressure to the common iliac artery, for arresting hemorrhage from the internal iliac artery or its branches, there quickly forms at the mouth of the wounded artery a clot of blood which prevents further hemorrhage; but if the compression be not properly applied, if it be not sufficiently strong, or not continued long enough to obliterate the vessel, the clot quickly becomes detached, and forms a so-called false consecutive aneurism.

The accompanying wood-cut (Fig. 422) shows the arteries of the pelvis, together with the internal epigastric and circumflex iliac, *in situ*.

I cannot better show the extremely grave importance and very difficult nature of these injuries than by relating a few cases that occurred during the late war:—

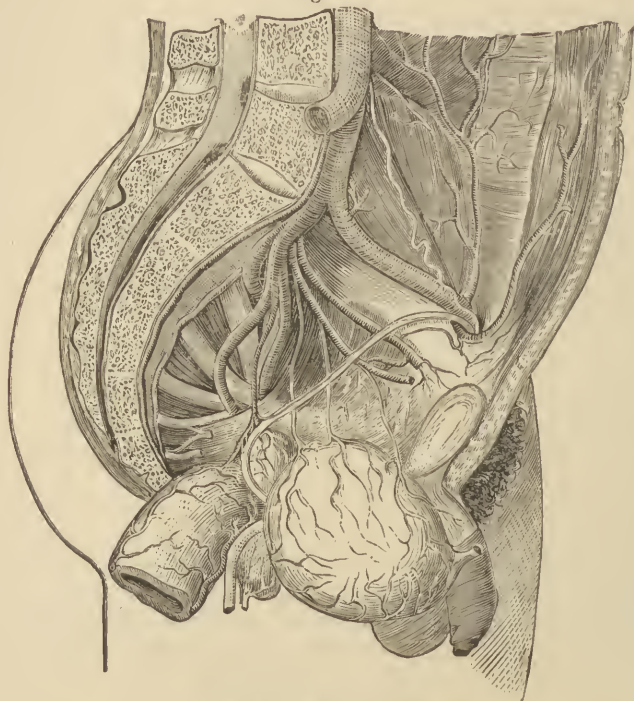
A soldier, aged 24, was wounded in the right buttock, May 9, 1864. He did well, apparently, until June 27, when hemorrhage of an alarming character occurred, and twenty-five ounces of blood were lost. It was checked outwardly by compression, but he sank, and, on the 29th, he died. The *necroscopy* revealed an immense accumulation of blood under the *gluteus maximus*, and the sac of what had been an immense traumatic aneurism, following a wound of the *ischiatric artery*. Seven additional instances in which this artery was wounded, were reported during the war, all of which proved fatal.¹ Two cases were treated by tying the artery itself, apparently with single proximal ligatures, one case by tying the internal iliac, one case by tying the common iliac, and one case by applying the actual cautery; but all in vain.

Internal Pudic Artery.—A soldier, aged 27, received a bayonet wound of the left pelvis, April 25, 1862.

¹ Medical and Surgical History, etc., Second Surgical Vol. pp. 326, 332, 333.

He suffered extreme pain in the left thigh and leg, which swelled largely, and he died on June 27. *Necroscopy.* The point of the bayonet entered the upper part of the left thigh, and passed through the sciatic notch, injuring the sciatic nerve, and wounding the internal pudic artery, whence a false aneurism formed, which became diffused through

Fig. 422



The arteries of the pelvis.

the whole pelvic cavity, forcing the rectum aside, displacing the sigmoid flexure of the colon, and rendering defecation difficult and painful. The aneurismal cavity held about three quarts of blood.¹ The swelling of the thigh and leg resulted from the pressure on the iliac veins that was exerted by the aneurismal swelling. Four examples of shot-wounds involving this artery were also reported.² The outward bleedings were arrested by plugging the wounds with liquor ferri persulph., and applying compresses with bandages, but they all terminated fatally.

Ilio-Lumbar Artery.—A soldier, aged 20, received a shot-wound of the right ilium, February 14, 1862.

Hemorrhage from the ilio-lumbar artery occurred on March 4, to the amount of thirty ounces, and recurred, at intervals, until the 24th, when death supervened.³ Another fatal case of bleeding from this vessel is reported.⁴ There were several large hemorrhages.

Gluteal Artery.—Illustrations of fatal bleeding from wounds of this artery were unhappily numerous during our late civil war. Thirteen cases were treated by applying compresses and bandages to the wounded part; and only two of them were saved.⁵ When the gluteal, the ischiatic, or the internal pudic arteries are wounded exterior to the pelvis, the surgeon must, at all hazards, perform the difficult operation of tying them, on each side of the

¹ Ibid., p. 323.⁴ Ibid., p. 36.² Ibid., pp. 304, 324.⁵ Ibid., pp. 327, 328.³ Ibid., p. 327.

bleeding aperture in their walls. In the following instance the gluteal artery was ligated in the wound with success:—

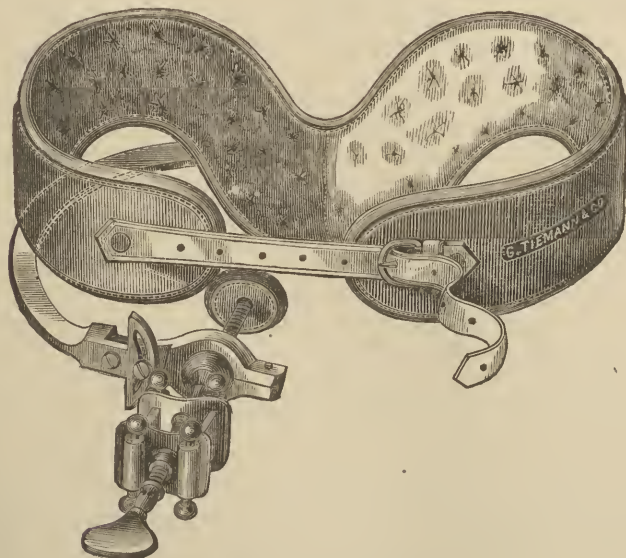
Colonel A. J. Warner received, September 17, 1862, a shot-wound of the right buttock; the missile penetrated deeply and lodged. On February 6, 1863, an operation for its extraction was successfully performed. During the manipulations, however, the gluteal artery was punctured; the hemorrhage immediately became very severe and apparently uncontrollable. "Thrusting my finger to the bottom of the wound," says Dr. J. H. Brinton, "I could readily feel the impulse of the jets of blood. I then requested an assistant to plug the wound with the end of a dry towel. This was done; at the expiration of a few seconds I quickly removed the plug, and while so doing was so fortunate as to see the gaping orifice of the main trunk of the gluteal artery, as that vessel emerged through the great sacro-sciatic foramen. I immediately compressed the trunk with the end of my index finger against the upper bony rim of the notch, thus arresting the hemorrhage instantly and completely. The seizure of the vessel with an artery-forceps and its ligation was then an easy matter. No further hemorrhage, to any extent, occurred; the ligatures separated in due time, and the patient made a happy recovery."¹

But in the cases where ligation of these arteries cannot be performed, well-adjusted compression must be faithfully applied to the trunk of the common iliac artery, and to the wounded vessel itself; and of these two modes of compression, the former is quite as important as the latter.

Figs. 423 and 424 represent tourniquets for compressing the common iliac artery and the abdominal aorta.

Internal Epigastric and Circumflex Iliac Arteries.—These vessels, also, are presented to view in Fig. 422, although it was specially designed for showing

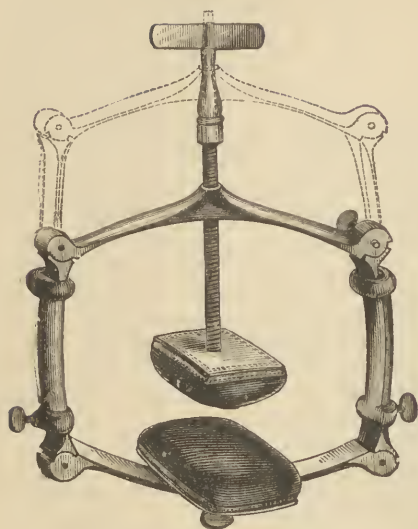
Fig. 423.



Erichsen's artery compressor.

the arteries of the pelvis. The deep epigastric and circumflex iliac arteries may be opened by simple flesh-wounds of the abdomen, as well as by those which penetrate its cavity, and thus hemorrhages may arise which will prove

Fig. 424.



Skey's artery compressor.

fatal, unless these arteries are seasonably and properly secured with ligatures. During our late civil war, five patients having wounds of the abdominal walls which did not open the abdominal cavity, were destroyed by the hemorrhages which occurred and recurred, in spite of the application of styptics and compresses, until exhaustion and death from loss of blood closed the scene.¹ In four additional cases where the circumflex iliac artery was opened by shot-wounds, the hemorrhages proved fatal, in spite, too, of the application of styptics and compresses.² In still another case of hemorrhage from a wound of the abdominal wall, where styptics (Monsel's salt) had been applied again and again without permanently arresting the bleeding, the external iliac artery was tied, but without success.³ These examples most emphatically teach that wounds of the

internal epigastric, circumflex iliac, and lumbar arteries should not be regarded as trivial; but as demanding the rigorous application of the rules for arresting hemorrhage from all wounded arteries of magnitude, viz., exposure of the bleeding aperture to view, and ligation of the artery on each side of it. Moreover, the application of distal ligatures is all the more necessary in these cases, because the terminal branches of the internal epigastric artery are directly continuous with those of the internal mammary, and the terminal branches of the circumflex iliac are directly continuous with those of the ilio-lumbar artery, as is shown in the accompanying wood-cut (Fig. 425); and, therefore, when proximal ligatures only are put on these arteries, when wounded, there still remains a great liability to the recurrence of hemorrhage from the regurgitation of blood through the distal part of the vessel into the wound, as soon as the blood-pressure is raised high enough by general reaction to expel the coagulum from the distal orifice in the artery.

Boyer speaks forcibly of the importance of ligation for hemorrhage from these wounds, and gives particulars of an instructive case of wound of the internal epigastric artery, that proved fatal, in which this measure had been neglected. Guthrie several times saw this artery tied with success. In the case of a Portuguese soldier stabbed in the belly with a sabre, there was profuse hemorrhage from a small wound made by the point of the weapon. This wound Guthrie enlarged until the wounded but undivided artery became visible; upon this two ligatures were placed, and the external wound was sewed up. The man recovered.⁴ In lesions of the abdominal walls, then, when the hemorrhage is severe, and the wound not large enough to allow the bleeding point in the artery to be seen, the surgeon must enlarge the wound until the punctured artery can be seen, and can be secured. We need not fear the hemorrhage as long as such a wound is open and we can place a finger on the bleeding point. But when the surgeon trusts to external pressure, and closes such a wound without securing the punctured artery

¹ Medical and Surgical History, etc., Second Surg. Vol., pp. 9, 10

² *Ibid.*, p. 324.

³ *Ibid.*, p. 10.

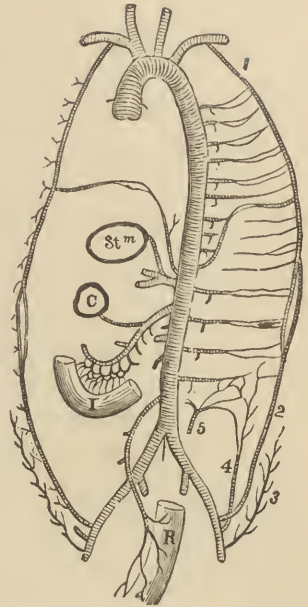
⁴ Commentaries, etc., p. 510, Am. ed.

itself, then there is abundant cause for anxiety. If these principles be important in hemorrhages of an ordinary character, they are much more important still when applied to the treatment of hemorrhages from the hypogastric, inguinal, and iliac regions. Legouest has twice had occasion to apply ligatures for profuse hemorrhage from flesh-wounds of the abdomen; once to the epigastric, and once to the circumflex iliac artery. Sometimes these vessels, when divided, retract greatly; it then becomes necessary to enlarge the wound considerably, in order to find and tie the bleeding mouths. This is especially apt to happen when the internal epigastric is severed near where it enters the sheath of the rectus. Sometimes, in punctured wounds of the abdominal parietes involving these arteries, the hemorrhage is inter-mural, the blood either escaping into the connective tissue and forming a sanguinolent tumor; or, burrowing between the great muscular and aponeurotic planes, the extravasation becoming widely spread and forming a flattened swelling. In both instances, the wound must be enlarged until the bleeding orifice can be seen and the artery properly tied. When from such extravasations sanguinolent abscesses result, they should be opened by timely incisions, lest there occur inflammation of the contiguous peritoneum, or purulent infiltration of the muscular bundles; the pus, if the operation be delayed, may become widely disseminated.

When these arteries are opened by wounds which penetrate the abdominal cavity, and the apertures in the integuments are closed without first securing the wounded vessels, the blood may flow inwardly and collect in great quantity in that cavity; this concealed hemorrhage may be so abundant as to prove fatal.

Internal Mammary Artery.—In mere flesh-wounds of the chest, as well as those which extend into its cavity, this vessel may be opened. Moreover, this lesion is not trivial and unimportant, as some surgeons have supposed; for, during our civil war, six cases were reported in which the internal mammary artery was opened, and in all of them the hemorrhage was very profuse, and the issue fatal. Wounds involving this artery, therefore, merit serious attention. Anatomically, the internal mammary is a branch of the subclavian artery, and the first that proceeds from the inferior aspect thereof; it descends behind the clavicle and the costal cartilages, but in close relation with the cartilages, along the front wall of the chest, but external to the pleura, alongside the margin of the sternum and about half an inch therefrom, until the sixth intercostal space is reached; here it divides into the musculo-phrenic and superior epigastric branches, the latter of which enter the sheath of the rectus abdominis, and terminate in or become continuous with the corresponding branches of the internal epigastric artery. The deep mammary arteries (Fig. 425, 1) are remarkable for the number of their inosculations and for the distant parts of the arterial system which they serve to connect. They anastomose with each other, and their inosculations, through

Fig. 425.



Longitudinal plan of the arteries of the trunk. 1, *Internal mammary*; 2, *Deep epigastric*. They are connected to the aorta by a series of intercostal, lumbar, and diaphragmatic arteries. 3, *Superficial epigastric*; 4, *Circumflex iliac*; 5, *Ilio-lumbar from internal iliac*. The anatomist will notice that it is chiefly the anastomosing branches of the arteries of the wall which are shown. (Struthers, *Anat. and Physiol. Obs.* Edin. 1854.)

the intercostal arteries, etc., with the thoracic aorta, encircle the thorax. On the walls of the chest, their branches connect the axillary and subclavian arteries; on the diaphragm, they form a link in the chain of anastomoses between the subclavian artery and the abdominal aorta (see Fig. 425); and in the walls of the abdomen they form anastomoses most remarkable for the remoteness of the vessels which they serve to connect, namely, the arteries of the upper and lower extremities (Harrison). When the aorta becomes narrowed or obliterated, the internal mammary arteries constitute the most important of the collateral channels for conducting blood to the lower extremities. Each of these arteries is attended by two *venæ comites*.

The hemorrhage in every one of the six cases of wound involving the internal mammary artery, reported during the late civil war, was secondary. In but two of them were ligatures applied. Judson, in one instance, tied the artery, but the method of operating is not stated; the bleeding was arrested, and did not return, but the patient continued to sink, and died six days after the operation from anæmia and traumatic pleuro-pneumonia. Bontecou, in another instance, where there was a so-called seton-wound of the chest, enlarged the wound of entrance, passed a piece of bandage through, and tied it over the ensiform cartilage, ligating the internal mammary artery; the bleeding, however, was not permanently arrested, and the patient died five days afterward from recurrent hemorrhage with pneumonia. Four cases were treated mostly by inserting plugs soaked in styptics, and applying compresses externally, but without benefit, as in the following examples:—

A soldier, aged 20, was wounded June 3, 1864, the ball penetrating at left side of sternum, near junction with second rib, and emerging above clavicle, fracturing both sternum and clavicle. Patient became much reduced from profuseness of suppuration and pleuro-pneumonia. On the 10th, profuse hemorrhage from the external wound occurred, and death followed in twelve hours. Treatment consisted in plugging the wound with lint soaked in liquor ferri persulph. *Necroscopy.* The internal mammary was found in the mutilated tissues with its mouth gaping; no other vessel wounded. Again, a soldier, aged 26, was wounded July 1, 1863, by a conoidal ball which fractured the humerus, passed along the clavicle, and lodged behind the edge of the sternum upon the internal mammary artery. On August 23 this vessel was opened by sloughing, and hemorrhage to the amount of thirty ounces occurred. Cold applications and compresses were applied, but on the next day the patient died. In the remaining two cases the blood flowed inwardly, and accumulated in great quantity, in the pleural cavities.¹

Secondary hemorrhage from this artery, then, is sometimes hard to detect, and often exceedingly difficult to control, and these results naturally follow its situation on the inner surface of the thorax, and the important offices which it performs in the organism.

No example of primary hemorrhage from the internal mammary artery was reported during the war; still this vessel must, not unfrequently, have been opened by wounds. The conclusion is irresistible that in most instances where this vessel was penetrated by wounds, the victims perished on the field of battle before assistance arrived, while in some instances where the victims survived for a time, the source of bleeding was not detected because the blood flowed inwardly, and the hemorrhage was therefore concealed.

In all stabs, as well as other wounds which cross the track of this artery, the occurrence of hemorrhage from the wound, without the spitting of blood, should lead the surgeon to suspect strongly that this vessel is involved, whereupon he should at once thrust a finger into the wound, and search for the open mouth of the artery, from which he will feel the blood issuing in

¹ Medical and Surgical History of the War of the Rebellion, First Surgical Volume, pp. 523, 524, 548.

jets, if his suspicions be well founded. From the internal mammary artery when wounded, the blood may flow outwardly, or, inwardly, into the anterior mediastinum, into the pleural cavities, and into the pericardium. The hemorrhage from this artery, when wounded, may soon cause death directly from loss of blood and syncope, or indirectly from asphyxia, by compressing the lungs when the blood flows into the pleural cavities, and from paralysis of the heart when the blood flows into the pericardium, so as to compress that organ. But if the external wound be not large enough to admit a finger for exploration, the diagnosis may be very difficult. When such is the case, as well as when the hemorrhage is suspended at the time of examination, anatomical considerations may afford presumptive evidence; and every deep wound near the margin of the sternum, from the first to the seventh rib, when bleeding therefrom, whether external or internal, occurs, should be enlarged, by incisions if necessary, until the bleeding point is brought into view, when a ligature should be applied to the artery on each side of the orifice. Moreover, the distal ligature is needed almost as much as the proximal, on account of the great freedom with which the terminal branches inosculate, as already stated. The artery, too, must be secured by tying it without delay, lest meanwhile there should occur such loss of blood as of itself to prove fatal.

Wounds of the internal mammary artery are often attended with division of the costal cartilages. This complication was present in more than half of the cases collected by Lourdes; and it is almost always present when the vessel is wounded below the fourth rib, particularly when the wound has been inflicted by cutting instruments.

Ligation of this artery is esteemed easy of performance in the first three intercostal spaces, difficult in the fourth, very difficult in the fifth, and almost impossible in the sixth. But when there is an open wound and the contiguous parts are much swollen and discolored by infiltration, or when the artery is much torn and displaced, as sometimes happens in those cases of gunshot fracture of the sternum, etc., which greatly disturb the relations of the parts, the operation of tying this vessel in the wound may become exceedingly difficult in any portion of its course. If the surgeon fail to secure it with ligatures under such circumstances, what then should be done? Baron Larrey, indeed, taught that wounds of this sort should always be closed, and the cure of bleeding left to nature; but there are very serious objections to this plan, which, in effect, leaves the patient to perish directly or indirectly from internal hemorrhage. Nélaton advised that an air-compressor in the form of a bag of India-rubber or gold-beater's skin should be introduced and inflated within the wound, but this instrument is fragile or unreliable at best, and not always at hand or within reach when wanted. It is best, then, to have recourse to the plan of Desault and Zang, and to place over the wound a fine piece of carbolated muslin or carbolated gauze, four or five inches square, pressing the centre of it through the wound into the thoracic cavity, and stuffing the glove-finger or bag thus formed with antiseptic cotton or lint; the angles of the compress are then brought together and tied like a purse, and the pad or ball of antiseptic cotton or lint is drawn gently outward, and made to compress the injured vessel against the sternum. To keep the pad in place, it may be fastened with ligatures to a roller bandage or any other convenient cylinder. The materials for Desault's or Zang's tampon are always at hand, the compress itself can be strongly made and safely applied; and, whenever the attempt to tie the artery in the wound fails, this *tamponing* is the best resource. It is approved by Velpeau and by Otis.¹ At any rate, the hazard of

¹ Op. cit., pp. 525, 549.

exciting inflammation in the pleura and lung by the presence of the tampon in the wound is much less to be dreaded than the danger of hæmothorax.

When the internal mammary artery is injured, the prognosis is always very grave; the risk, too, of secondary hemorrhage is by no means small, as the cases (six), related or referred to above, clearly show.

Intercostal Arteries.—These vessels, called specifically the posterior intercostal arteries, arise from the back part of the thoracic aorta, and pass to the intercostal spaces, where, after coming into relation with the intercostal veins lying above and the intercostal nerves lying below, each of them divides into two branches, which run along the borders of the contiguous ribs between the two planes of intercostal muscles, and, finally, anastomose with the anterior intercostal arteries, branches of the internal mammary. The branch corresponding with the lower border of each rib is usually much larger than the other. Posteriorly, the intercostals are quite large vessels, and, coming directly from the main artery of the body, they give rise, when wounded, to profuse and obstinate hemorrhages. During our civil war fifteen such cases were recorded, eleven of which, or 73.33 per cent., proved fatal from hemorrhage; and in one instance the thoracic cavity was found to contain two quarts of blood.

Occasionally, these arteries are opened by stabs or incised wounds of the chest received in affrays; I have known two cases of such incised wounds. In each instance the injured vessel was promptly secured in the wound by ligatures without much difficulty, the chest-wound was then closed, and recovery speedily followed.

Sometimes, too, simple fractures of the ribs are attended with puncture or laceration of these arteries; and when the pleura costalis is also torn in such a way that the effused blood can readily escape into the thoracic cavity, death from concealed hemorrhage may soon ensue, as happened in the following instance:—

An artillery-man was struck, whilst fencing, with a light cane upon the eighth rib of the right side. There was no outward mark of injury, but he became collapsed, and died eight hours afterward. On *autopsy*, the right pleural sac was found to contain about five pints of blood. The eighth rib was found fractured, and a twig of the intercostal artery entering the bone at this point was torn through, while the trunks of the intercostal artery and vein were uninjured.¹

Most frequently, however, the intercostal arteries are found opened by, or in connection with, fractures of the ribs that are compound; such, for instance, as occur in gunshot-wounds of the chest. The fifteen examples reported in the *Surgical History of the War* were all cases of wound by gunshot missiles; and the intercostal arteries were injured either by the fragments of comminuted bone, or by the missiles themselves. But gunshot projectiles that are small or minute may open the intercostal arteries without breaking the ribs, and thus cause fatal hemorrhage, as occurred in the following case:—

A young man, aged 15, received a discharge of small shot at forty-eight paces. He instantly fell, but soon got up and ran about six hundred paces, when he again fell exhausted. He was taken home, and died thirty-eight hours after the mishap. *Autopsy.* One shot had penetrated his right chest between the first and second ribs, near the sternum. The right pleural cavity contained twenty-eight ounces of blood. The right lung was compressed to one-fourth of its normal bulk, and wounded. Posteriorly, the shot also had passed through the costal pleura at the inferior border of the sixth rib, about two inches from its head, and had lacerated the intercostal artery. From this wound had issued the fatal hemorrhage (Graefe). Here, too, the wounded vessel had considerable size, for its origin was not far away.

¹ *Medical Times and Gazette*, Dec. 2, 1860, p. 607.

Injury of the intercostal artery may be predicated in lesions that involve its track, when the wounded person does not spit blood while the symptoms of hemorrhage, internal as well as external, are urgent. If the wound be large, bright-red, but not frothy blood may be seen issuing therefrom; if the wound be probed with a finger, the blood may be felt issuing in jets from the aperture in the artery. When this vessel is lacerated without there being an external wound, and blood flows into the pleural sac, as happened in two instances mentioned above, the symptoms are those of rapidly occurring hæmothorax. Injury of this artery near its origin is always attended with dangerous bleeding. In shot fractures of the ribs it is always of very serious import, from risk of intermediary and secondary, as well as of primary hemorrhage. Of the fifteen cases reported in the "Surgical History of the War," six had primary, five intermediary, and four secondary hemorrhage.

When the intercostal arteries are punctured by stabs, it may be necessary to enlarge the external wound in order to get at and secure the injured vessel with a ligature placed on each side of the puncture. Generally, when the intercostal arteries are opened by external wounds, the hemorrhage should, if possible, be stanchd by tying them on this plan; and the efforts of the surgeon should first be directed to the accomplishment of this purpose, meanwhile suppressing the bleeding by applying a finger to the aperture in the vessel whence the blood issues, on the inside of the wound, until the preparations for applying ligatures can be made. Then, still restraining the bleeding with his finger in the wound, the surgeon should extend the wound posteriorly with a scalpel held in the other hand until he lays bare the artery between the two planes of intercostal muscles, and passes round it a ligature of carbolized silk or catgut, on tightening which the hemorrhage from the cardiac side of the wound will be effectually suppressed; the application of a distal ligature completes the operation. When the wound is fresh and the parts sound, no very great difficulty is usually experienced in finding and tying the intercostal artery in the wound itself.

Sometimes, however, when the wound is no longer fresh and the parts are not sound, as, for instance, in secondary hemorrhages, it may be advisable to follow the old method of Gérard, and include the rib, nerve, and vein in the ligature as well as the artery; it will be still more advisable to do so if the patient has already lost much blood. Restraining, then, at once the bleeding by inserting a finger into the wound so as to compress the open mouth of the artery (an assistant may do it if required), the surgeon should prolong the wound posteriorly in the course of the artery, that is, toward its origin, and taking the blunt-pointed, strongly-curved needle belonging to a chain-saw, or one of the many instruments which have been specially devised for this operation, suitably armed with a ligature of carbolized silk, catgut, or silver wire, he should dip the point of the needle under the lower edge of the rib beneath the artery, and following closely the inner surface of the rib with the blunt point of the instrument, external to the pleura, he should, by depressing the handle or eye of the instrument, make the point appear, covered by the integuments, at the upper margin of the rib. The point should now be uncovered by a small incision, and protruded through it until the ligature can be seized hold of and placed; then the needle should be withdrawn. The ends of the ligature may be disposed of by tying them firmly over a roll of adhesive plaster; or they may be passed through the corresponding holes in a bone or a rubber button of suitable size, and then be firmly drawn and knotted. Another plan of dealing with the ligature is to pass the end, which was removed from the eye of the blunt-pointed, strongly-curved needle into the eye of an ordinary good-sized needle and re-insert it through the puncture of the integuments at the upper margin of the rib, carry it between the

integuments and the external surface of the rib, and bring it out of the original wound, where the two ends are crossed, drawn tightly, and knotted. This proceeding is not difficult to execute, and constitutes a subcutaneous ligation of the intercostal artery, vein, nerve, and rib. The upper puncture should be closed with an adhesive strip. With a little care this operation may readily be performed without piercing the costal pleura, as B. Howard has shown.¹ In general, it is well to secure the artery in the same way on the distal side of the wound, as practised by B. Howard. The operation with a blunt-pointed, strongly-curved needle, described above, has one great advantage—the bleeding may be stopped from the first moment of seeing the patient, as it can always be controlled by pressure applied in the wound until the operation is completed. Professor Gross has suggested the drilling of a hole through the rib, and the passing, in this way, of a silver wire around the artery. Whatever plan is followed, care must be taken not to wound the pleura unnecessarily, which can be avoided only by keeping close to the inner surface of the rib, and by thoughtfully manipulating the instrument in other respects. Professor D. H. Agnew's instrument is the best for tying the vessels in with the rib.

Boyer held that lateral pressure was the only remedy for hemorrhages from wounded intercostal arteries. When from any cause ligation cannot be satisfactorily performed, Desault's excellent method of applying lateral pressure to the artery in the wound with a tampon, described above, merits a thorough trial, being equally suited for hemorrhage from the intercostal and for bleeding from the internal mammary arteries. If the pleura and lung be intact, the risk of wounding them is avoided; but if they be already wounded, it is the least irritating dressing that can be employed. There is no danger of dropping the tampon of Desault into the pleural cavity and thus losing it, as has happened in plugging such wounds with sponges or charpie. Moreover, it has proved successful in a considerable number of cases (Bégin, Velpeau, Jamain) in controlling the hemorrhage without exciting inflammation in the pleura or the lung (Otis). In hemorrhage from chest-wounds which open the pleural cavity, the application of compresses externally does no special good; for it directs the flow of blood inwardly, and thus conceals the hemorrhage without abating it.

Guthrie reports one case where secondary bleeding from an intercostal artery recurred several times, and was ultimately suppressed by the oil of turpentine, applied on a dossil of lint, and pressed on the bleeding spot by the fingers of assistants until the hemorrhage ceased; recovery followed. Such styptic solutions, however, as those of the perchloride and persulphate of iron, are not any more applicable to wounds of the chest than are bleeding than they are to wounds of other parts; and when the pleural sac is also opened by the wound, they might do much harm, if applied, by getting into the pleural cavity. So, too, with all the styptic substances which are used in a pulverized state, even those against which, *per se*, valid objections cannot be raised, as they can be against Monsel's salt, etc.: their employment in such cases is hazardous, because they may fall into the pleural cavity. Many other plans of dealing with this exceedingly troublesome form of hemorrhage have been proposed by authors. Some of them are dangerous, others trivial, and others again more ingenious than useful. Inasmuch as bleeding from the intercostal arteries is not unfrequently met with in cases where the pulmonary tissue also is lacerated, the surgeon, in such cases, must avoid doing anything which will increase the hemorrhage from the lung. When, however, an intercostal artery is wounded between the sternum and the middle of the ribs

¹ American Medical Times, vol. vi. p. 52.

—where, perhaps, the majority of wounds of the chest occur—the hemorrhage is not always severe; but the injury of an intercostal artery, towards or near its origin, always causes very dangerous bleeding, and here the vessel is secured with much difficulty on account of its depth. A recollection of these points may assist the surgeon not a little in determining the plan of treatment to be employed.

When the intercostal arteries are lacerated without there being an external wound, and inward bleeding occurs, operative skill is generally powerless to stop it. Guthrie, indeed, suggests, in commenting on a case of this sort, that auscultation would have made known the extravasation, and that relief might have been given by an incision over the spot where the uneasiness was felt; for the loss of blood was not sufficient of itself to destroy life.¹ It is true that, had the spot been known where the artery was injured, in this case, it might have been cut down upon and tied; but it remains to be proved, in future cases, whether auscultation and the sensations of the patient can afford such sure information on this point as would authorize the surgeon to operate. As the symptoms in these cases are usually the symptoms of hemothorax, so the treatment must, in general, be the treatment of that accident.

CONTUSED WOUNDS OF ARTERIES.

The bloodvessels, as well as the integuments, the muscles, and the bones, often suffer from contusions. The “black and blue” spots, called ecchymoses, which appear in all bruises, do so because the capillaries are crushed, and their contents escape. When arteries of some size are mashed by blows, large subtegumentary swellings may form from blood escaping into the connective tissue, of which accident I have seen some notable examples where the temporal and femoral vessels were involved. Large arteries, however, are, in some measure, protected from injury by bruising (1) by their positions, which, generally, are deep and sheltered; (2) by their capacity to flatten readily, which results from the elasticity of their walls and the fluidity of their contents; (3) by the strength of the arterial sheaths and the looseness of the connective tissue which surrounds them, whereby considerable freedom of movement in lateral directions is allowed; and (4) by the prominence of contiguous muscles or other organs which serve to receive or to deflect the vulnerating forces. Contused wounds of arteries may be produced by falls and by blows with blunt instruments; I can call to mind at least two such cases; but the most common cause is injury from gunshot projectiles.

Bruises of bloodvessels, which fall short of crushing them, may nevertheless do great harm. Boyer asserts that the contusion of large arteries is sometimes followed by their rupture and the formation of a diffuse traumatic aneurism; and if the percussion be not great enough to rupture their coats, it will weaken them to such a degree that they will afterwards yield to the impulse of the blood, and form a true aneurism.

Gunshot bruises of arteries which do not directly open them are still attended with ecchymosis of the sheaths. The vasa vasorum, too, are lacerated, and blood may be extravasated between the artery and its sheath in such quantity as to narrow considerably the tube of the vessel. Now, under appropriate treatment, this extravasated blood may be absorbed, the bloodstasis and local irritation may disappear, and the bruised part may be completely restored to a healthy state. But if, on the other hand, there be no treatment at all, or that which is inappropriate, the blood effused in the sheath is

¹ Commentaries, etc., p. 475, Am. ed.

not absorbed, the inflammatory process is lighted up in the bruised part, the tube of the artery is still further narrowed by the occurrence of inflammatory swelling, and occlusion of the artery may follow, with gangrene of the region deriving its supply of nutrient blood from the occluded vessel, as happened in the following instance:—

A soldier was wounded November 27, 1863, by a minié-ball which entered the left thigh, on its antero-exterior surface, six inches below the anterior superior spinous process of the ilium, dipped beneath the integuments and deep fasciæ, and emerged from its inner surface four inches below the pubes, passing thence into the other thigh. Gangrene of the left foot soon followed. On December 14, the left leg was amputated at the junction of its lower and middle thirds; the artery was controlled during the operation by pressure of the thumb alone; there was very little hemorrhage; the tissues were flabby at the place of section. Pyæmia ensued, and on January 14, 1864, the patient died, on the forty-eighth day after the injury and the thirty-first after amputation.

Autopsy.—Both orifices of the wound in the upper part of the left thigh were closed, but the track of the ball was occupied by an abscess containing thin fetid pus. The ball had passed behind the femoral artery, impinging against its sheath, however, and bruising it. At this point the walls of the artery were much thickened, and its calibre lessened one-half. The sheath contained a firm coagulum about one inch long. The specimen was sent to the Army Medical Museum, and is thus described in the Catalogue: “A wet preparation of the upper portion of the left femoral artery, with the walls much thickened by a coagulum in the sheath, following impingement of a ball, which induced diminution of calibre.”¹

To briefly present the points of this case: The missile bruised the femoral vessels without opening their sheath, and the hemorrhagic and inflammatory swelling constricted the tube of the artery very much at the bruised part—so much is certain; it is highly probable also that the coagula which formed in the canal of the femoral artery, where it was inflamed and constricted, were swept onward by the blood-stream, as emboli, into the tibial arteries, and plugged them to such extent as to cause, with the lessened blood-supply from above, gangrene of the foot.

Another preparation belonging to our Army Medical Museum sheds additional light on the same point. It is thus described in the Catalogue: “A wet preparation of the popliteal artery, showing a clot formed in it from inflammation along the track of a ball which did not involve the arterial coats in the sloughing process. Amputation was performed to obviate sphacelus, and the patient recovered.”² In this example, the ball, in its passage, bruised the popliteal artery; there followed inflammation and occlusion by coagulum of the bruised portion of the vessel; from this arrest of blood-supply, gangrene of the leg ensued.

In a case reported by Guthrie, which belongs to the same category, the ball passed between the femoral artery and vein. The patient died sixteen days after the injury from gangrene of the foot and leg. After death, Mr. Guthrie obtained the specimen. The coats of the artery were not destroyed in substance, although wounded. At this spot the vessel was “much contracted in size, and filled above and below with coagula, which prevented the transmission of blood.” The artery was therefore impervious. The coats of the vein were but little injured, although it was “filled by a coagulum and impassable” at the bruised part.³ In this case, too, the traumatic arteritis caused by the bruise was the chief factor in producing the arterial occlusion.

¹ Catalogue A. M. M., p. 456, Specimen 2114.

² *Ibid.*, p. 457, Specimen 2150.

³ Diseases and Injuries of Arteries, p. 242.

Another case is related in the "Surgical History of the Crimean War:"—

P. Ryan, aged twenty-one, on June 8, received a canister-shot wound (supposed) through the left thigh at its upper part, involving the track of the femoral vessels. On the 16th, gangrene of the foot appeared, and the leg was amputated just below the knee. On the 18th, gangrene attacked the stump; on the 19th, it extended up the thigh; and on the 20th, death occurred. *Autopsy*: "The ball was found to have passed through the thigh internally to the sheath of the femoral vessels, which it had grazed, but not opened. The artery at this point was slightly contracted for a space about an inch in length, but pervious, and containing no coagulum; and, beyond the contraction, its calibre showed no marks of inflammation. The vein, however, was not only also slightly contracted, but its internal surface was inflamed and filled with partially organized lymph, as far up as the entrance of the deep iliac vein, and downward for about two inches from the wound. Its course was thus entirely sealed; but nothing like pus could be found in the femoral or iliac veins, nor in the venous system anywhere."¹ Here gunshot contusion of the femoral vessels caused inflammation with contraction of their walls, and thrombosis with occlusion of their canals; in the artery, however, the blood-clot appears to have been swept into the branches, producing embolism of the same, and consequently, gangrene of the foot, leg, and thigh, in successive stages.

These four examples show very clearly what disastrous consequences may follow the bruising of bloodvessels and their sheaths by the strokes of passing bullets, or by other adequate means. The usual ecchymosis of the bruised part may be attended with hemorrhage into the sheath, compressing and partially occluding the vessel itself; to be followed by inflammation of the walls of the injured vessels with thrombosis, or embolism, and gangrene from arrested blood supply.

But if the extravasated blood be absorbed, and if the inflammatory process be *not* kindled in the bruised vessels, then the obstruction to the circulation may prove but temporary, and complete recovery may eventuate, as happened in the following instance:—

John English, aged twenty, on June 22 received a wound from a musket ball which passed through the thigh. The wound was directly in the course of the femoral vessels. As he was reported to have lost a quantity of arterial blood on receipt of the injury in the trenches, it was feared that the femoral artery had been wounded. The temperature of the limb was sensibly diminished, and the pulsation of the arteries in the foot could not be discerned for several days. The patient was exceedingly restless, and complained of pain and numbness in the calf of the wounded limb. No hemorrhage, however, occurred; the limb regained its natural temperature, and recovery slowly followed.²

A widely different and a comparatively frequent type of arterial contusion next claims our attention; a type which is characterized by the occurrence of secondary hemorrhage. Among the consequences of simple contusion that are most to be dreaded, where large arteries are concerned, is ulcerative inflammation and sloughing of the injured vessel. In some of these cases, the bruised fibres of the arterial tunics are too greatly damaged to retain their vitality; hence they must be detached by an ulcerative process which may open the canal of the artery. Contused differ from other wounds chiefly because the stricken part may suffer a loss of vitality, and will have to ulcerate or slough away before any reparation can be effected; inflammation is supposed to be necessary to the consummation of this process. In other instances, a destructive inflammation *per se* is kindled in the bruised vessel, either by the depraved general condition of the patient, or by his unwholesome surroundings, or by bad treatment, which also may open the canal of the artery and cause secondary hemorrhage. I can most clearly, and at

¹ Surgical History of the Crimean War, vol. ii. p. 343.

² *Ibid.*

the same time briefly, discuss this important subject by relating a few cases taken from my own note-book and from the "Surgical History" of the late War.

A cavalry-soldier, aged 24, was admitted to Stanton Hospital, under the writer's charge, from the field, June 4, 1864, for a wound of his right leg at the ankle, inflicted by a minié-ball, on May 31. It was resolved to continue the effort, which had already been commenced, to save the limb. On the night of the 7th, arterial hemorrhage from the wound supervened, and about a pint of blood was lost before it was checked. On the morning of the 8th, I amputated the wounded leg, at the place of election, by the flap-method, under sulphuric ether, with but trifling loss of blood, and but little shock; and after the operation the patient's general condition was favorable.

Examination of the amputated member showed that the posterior tibial artery had been grazed by the missile, and that several small bits of bone had been driven into the walls of the artery at this place. The hemorrhage had occurred from ulceration of the bruised part of the artery, and from detachment of the minute fragments of bone that were stuck in it. The ankle-joint was full of purulent matter, the lower end of the tibia was badly comminuted, and the astragalus also was injured by the missile. The patient did well for some time; but thirteen days after the operation he died of pyæmia. In this case, primary amputation ought to have been performed, or the artery ought to have been secured primarily with the ligatures above and below the bruise, because the injury was of such a nature that otherwise secondary hemorrhage was inevitable.

A soldier, aged forty, wounded May 28, 1864, was admitted to Stanton Hospital, under the care of the writer, on June 12. A conoidal ball had passed through the ankle-joint from within outward, in such a way as to involve the track of the posterior tibial artery. On the next morning, while the assistant-surgeon was in the ward, arterial hemorrhage from the wound suddenly occurred, and about three ounces of blood were lost before it was suppressed. I was immediately brought to the patient. There was then no pulsation in the posterior tibial artery at the ankle, while that of the anterior tibial could be distinctly felt. It was evident that the hemorrhage proceeded from the posterior tibial artery. Without delay I had the patient etherized, and I amputated his injured leg in the lower part of its middle third, with but little loss of blood, and with little or no shock.

Examination of the amputated limb showed that the posterior tibial artery had been grazed and contused by the missile; and that it had been opened by exulceration of the bruised portion of its walls, whereby the hemorrhage was caused. The lower end of the tibia, the astragalus, and the os calcis had severally sustained comminuted fracture. The patient died nine days after the operation, apparently from exhaustion; but I believe that he had osteo-myelitis, and that this caused his death. In this case, too, the chance of recovery would have been much increased by primary amputation, or by tying the artery above and below the bruise in the primary period; because the nature of the arterial lesion was such that in the absence of these operative procedures the occurrence of secondary hemorrhage was inevitable, and only a question of time.

A western cavalry soldier was wounded in the neck by a conoidal ball, which entered above the outer third of the right clavicle, and emerged above the middle third of the left clavicle, on July 4, 1864, in a brawl. Simple dressings were applied. Secondary hemorrhage from the common carotid artery occurred on the 11th, which was temporarily controlled by applying liquor ferri persulph.; but, on the 12th, the patient died. The *autopsy* revealed an aperture in the carotid, about two lines in diameter, and about three-fourths of an inch above its origin.¹

In each of these three cases the hemorrhage was due to the normal separation and detachment of bruised tissues from the walls of an important artery.

There is another form of gunshot contusion of bloodvessels which belongs to the same category, but is much more extensive: "When a limb is crushed

¹ Medical and Surgical History of the War of the Rebellion, First Surg. Vol., p. 412.

by shot or shell, but not carried away, the coats of the artery are often found to remain continuous, and primary hemorrhage to be thus rendered impossible, although their vitality may have been totally destroyed."¹ I have never seen this form of vascular contusion, but still I can readily conceive that it sometimes occurs in those terrible bruises of the extremities which are not unfrequently produced by cannon balls, or bombs, or rifled shells, without breach of the integuments. In such cases the continuity of the bloodvessels is preserved until the dead tissues become separated from the living, for the same reason that the integuments remain unbroken until this time arrives.

The Army Medical Museum at Washington contains a specimen of railway injury, which must be classified under the head of contusions. It is "a wet preparation of the axillary artery, curiously obliterated at the passage of the pectoralis minor. The attached subclavian vein is ruptured. In this subject the humerus and clavicle were comminuted, and the soft parts between the shoulder-joint and the sternum pulpified by being crushed between two cars. No pulsation could be felt at the wrist, and sphacelus from the shoulder to the arm occurred."² The patient was admitted to hospital on July 20, and died on the 23d.

Again, contusions of arteries not unfrequently lay the foundation for unhealthy inflammations to open their channels and thus cause secondary hemorrhage, when, but for the occurrence of a destructive inflammation, their walls would have remained intact, as happened in the following instance.

A soldier, aged 28, was wounded at Gettysburg, July 2, 1863, by a minié-ball, which passed through the inner side of his left arm, across the track of the brachial artery, about three inches below the fold of his armpit, without injury to the humerus; and, thence, proceeding to his thorax, made a so-called seton-wound on the left side thereof. He was taken to a general hospital where, after doing well for some time, the bullet-hole in his arm was attacked with a sloughing inflammation which connected the two orifices in an open sore; and on the night of August 3, thirty-two days after the casualty, it opened the brachial artery. Great loss of blood ensued, until a proximal ligature was applied to the artery in the wound. He did well after that, and the wound healed in a short time. On October 16, 1864, when I last saw him, the wounded arm was much atrophied, blue-colored, colder than the sound limb, weak, and much restricted in the range of its movements. There was a large cicatrix on the inner side of his left arm, two or three inches below the armpit. There was a radial pulse in this limb, but it was quite small in volume, and quite feeble in strength. On the 17th, he was discharged from the service for these disabilities, at Stanton Hospital. In this case the bruising of the artery, in all probability, would not have been attended with any serious consequences, had the wound remained free from destructive inflammation; for a month or more elapsed before hemorrhage occurred, and arterial fibres killed by contusion would have separated long before that time.

An example of secondary hemorrhage from a bruised common carotid artery, occurring in a person whose vitality was much lowered by simultaneous injury of the spinal cord, is reported in the "Surgical History of the War."

A soldier received a shot-wound of the neck, January 3, 1863, and was admitted to hospital on the 4th. The missile passed through his neck, dividing the inter-vertebral substance and laying open the spinal cord. He did not seem to suffer much; but, on the night of the 14th, secondary hemorrhage supervened, and before any assistance could be rendered, he lost so much blood that he died on the evening of the 15th. At the *neuroscopy* it was found that sloughing of the common carotid artery had taken place.³

¹ Surgical History of the British Army in the Crimean War, vol. ii. 340.

² Catalogue A. M. M., p. 468, Specimen 1640.

³ Medical and Surgical History of the War of the Rebellion, First Surg. Vol., p. 412.

TREATMENT OF CONTUSED WOUNDS OF ARTERIES.—Contused wounds of arteries may be complicated by hemorrhage, the presence of foreign bodies, inflammation, and gangrene. When, from the crushing of arteries by blows, extravasation of blood occurs in large quantity, it may be necessary to ligate the injured vessels in order to suppress the bleeding. If a considerable artery be opened, it must be tied; compression would only increase the irritation already existing. For the treatment of false primitive or consecutive aneurisms arising from this cause, consult the section on Traumatic Aneurism. When the contusion is very severe, and the quantity of extravasated blood very great, and when it collects in a mass in the crushed connective tissue and forms a so-called hæmatoma, the part is commonly black, which might lead us to fear gangrene; but if this blackness disappear on pressure, and if it be soft, and unattended with pain or great swelling, and if the affected parts be still warm, we may conclude that life still exists in them, and that resolution may take place, notwithstanding the collection of blood in the connective tissue. There are many examples of sanguineous tumors (hæmatomata) which have terminated by resolution, after a greater or less time; but it sometimes happens that all of the effused blood cannot be taken up by the absorbents or the veins, and then we are compelled to discharge it by an incision; but such openings are not to be made until we have waited long enough to know that resolution is impossible. To hasten the disappearance of hæmatomata, the application of lead-water generally proves useful; and if much pain be present, the application of lead and opium wash in a warm or tepid state usually brings speedy relief.

Shot-wounds involving the tracks of large bloodvessels must always be the subjects of careful scrutiny and much anxiety on the part of intelligent surgeons, although there may be no bleeding at first. If any sign of considerable injury to the artery itself be discovered on exploring the wound with a finger, if the pulsations be found much weakened in the trunk or branches of the injured vessel below the wound after full reaction, the artery should at once be secured by ligatures applied above and below the bruised part; or, perhaps, the limb should be amputated primarily; otherwise secondary hemorrhage or gangrene is sure to follow, as the cases related above fully prove. But, of course, a bruise on a small spot or portion of an artery may not always diminish the force of the circulation before sloughing; and, in very severe contusions, the canal of the vessel may be closed before sloughing has time to occur. We must not put too much confidence in any one symptom, therefore, but provide, in all suspicious cases, for the contingencies mentioned above.

If it be deemed expedient to treat the case without primary ligation or amputation, we should strive to lessen the risks by abating the inflammation of the bruised part of the artery, but especially that which is ulcerative or phagedenic in character. The wounded part should be kept at perfect rest. The surroundings of the patient should all be of the most wholesome character. The practice of applying poultices with a view to favor the occurrence of suppurative inflammation, is bad in such cases, because it insures suppuration throughout the whole extent of the wound. Carbolated water-dressings (1 to 200) will allow the necessary detachment of the disorganized tissues just as well as poultices, without inducing suppuration in the parts which are disposed to undergo adhesion. Indeed, it is possible for the reparation of the parts lost by the severity of contusion to be effected under such a dressing without the occurrence of suppuration or granulation. The retention of secretions in the wound must be avoided by the thorough use of Chassaignac's drainage tube. The utmost cleanliness should be observed, and all the dressings should be of an antiseptic nature.

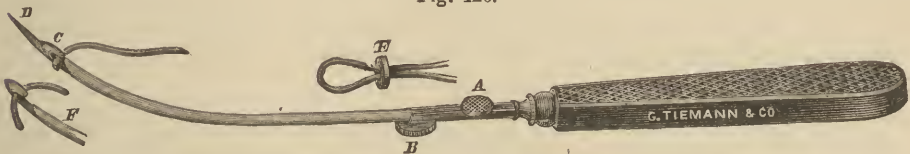
Meanwhile, we should constantly be on the lookout for secondary hemor-

rhage, and the attendants must be told what to do in case it appears, until we can arrive at the bedside of the patient. When secondary hemorrhage occurs, the vessel should generally be secured in the wound by ligatures applied on each side of the bleeding orifice, as was done in the following instance:—

A soldier, aged 19, was wounded on May 28, 1864, by a conoidal ball, which passed through the left axillary space. On June 12, secondary hemorrhage from the axillary artery, to the amount of twenty ounces, occurred. On the 15th, the axillary artery was ligated above and below the wound, under chloroform. The vein was found injured, and was also ligated. The hemorrhage did not recur; but death ensued on the 28th, thirteen days after the operation. The *autopsy* revealed no evidence of phlebitis or pyæmia; and the patient appears to have succumbed to the prostration consequent on the loss of blood prior to the operation.¹

The axillary artery and vein, in this case, were both opened by ulceration following gunshot contusion, and both vessels were quite properly treated by securing them in the wound with double ligatures. If traumatic gangrene occur, amputation is our sole expedient. If the lesion of the artery be complicated with compound comminuted fracture, and the region involved be the lower extremity, it is sometimes preferable to amputate at once, especially if the knee or ankle joint be opened. When, however, it seems probable that the limb can be saved although the blood-supply derived through the bruised artery be cut off, we may tie the vessel above and below the lesion. Anti-septic dressings and the employment of Chassaignac's drainage-tubes are of great utility in these cases.

Fig. 426.



Drainage-tube carrier of Dr. John B. Hamilton, Surgeon-General of the United States Marine Hospital Service.

To emphasize the necessity which there is for thorough drainage in treating wounds attended with arterial or venous contusions, this figure of a useful instrument is presented.

LACERATED WOUNDS AND RUPTURES OF ARTERIES.

The lacerations and ruptures of the walls of arteries, which claim the attention of surgeons, may be incomplete, as well as complete, in degree; and may occur in either form without the presence of any corresponding external lesions. In those enormous wounds of the extremities which are left behind when the limbs are plucked off by the action of powerful machinery in manufactories, or crushed off by the impact of cannon-balls in war, the arteries are torn completely across, and are often seen hanging out from the raw surface and pulsating quite down to their ragged and contracted ends, which, on examination, are found completely closed by plug-like coagula. When a limb is carried away by a round shot, the principal artery, vein, and nerves will almost invariably be found hanging from the wound, torn off at a point much more distant from the trunk than the remainder of the soft parts; and the end of the artery—lacerated, contused, contracted, and gener-

¹ Medical and Surgical History of the War of the Rebellion, First Surg. Vol., pp. 555, 556.

ally filled, after a very brief interval of time, with coagulated blood for a few lines from its extremity—above that point often pulsates quite strongly, though freely exposed to the air, as in the following instance observed in the Crimean War:—

A man had his left arm torn off at the shoulder-joint. The limb was completely separated from the trunk, too little of the integuments being left to cover the wound. The axillary artery appeared to have bled very little, if at all, at the moment of the injury, and there was no subsequent hemorrhage. The artery and vein were laid bare for full three inches of their course by the laceration; the ends of these vessels for three-quarters of an inch were curved, plugged with coagulum, and tapering to a point; the pulsation of the artery was full to the very base of the plug of coagulum.¹

Guthrie saw a soldier who had his arm carried away by the bursting of a shell. The axillary artery as it becomes brachial was torn across, and hung down lower than the other divided parts, and pulsated to the very extremity. Pressed and squeezed between his fingers in every way in order to make it bleed, it still resisted every attempt, although apparently by the narrowest possible barrier, which appeared to be at the end of the artery, and formed by its contraction. The canal was marked by a small red point, to which a very slight and thin layer of coagulum adhered, the removal of which, however, did not produce hemorrhage. In another case of like character, Guthrie cut off the end of the artery at less than one-eighth of an inch from the extremity, and then it bled with its usual vigor. In both cases the artery was contracted for that distance, so as to leave little or no canal at its orifice, and what there was was filled by a pin-shaped coagulum.²

With a view to illustrate the effects of avulsion on the bloodvessels, Mr. Joseph Bell showed the common femoral artery and vein of a man whose lower extremity had been torn off by machinery. The abdominal cavity was opened and the intestines protruded; but, notwithstanding, he survived thirty hours. The artery and vein were completely occluded by firm coagula, and the external coat was twisted to a fine point at the place of rupture.³

But the reader must not infer from these examples that the hemorrhage ceases spontaneously in all cases where limbs are torn off by machinery or by cannon-balls, without the loss of much blood; for such is not the fact. In the largest arteries, such as the common femoral, and occasionally, though much less frequently, in smaller vessels, hæmostasis does not always happen when they are disrupted, unless it is aided by the occurrence of syncope; and then the hemorrhage often proceeds to such an extent as to prove fatal, as happened in the following instance, which also occurred in the Crimean War:—

A soldier had his leg below the knee carried away by a round shot. He lost much blood before a tourniquet was applied, and was so much collapsed when received at the hospital that an operation was out of the question. The wound was dressed and the tourniquet removed; but he never rallied, and died nine days after the casualty, although no further hemorrhage occurred.⁴

During the progress of our civil war, several cases came to my own knowledge in which the ragged stumps of limbs torn off by cannon-balls or shells bled profusely at the moment of injury, and afterward did not entirely cease to bleed until ligatures were applied. In some of them the loss of blood was so great as to cause a fatal result of itself, although surgical aid was promptly afforded.

When limbs are plucked off from the trunk by machinery, however, as not unfrequently happens in manufactories, there is usually not so much hemor-

¹ Surgical History of the Crimean War, vol. ii. p. 340.

² Diseases and Injuries of Arteries, p. 224.

³ British Medical Journal, January 18, 1873, p. 77.

⁴ Op. cit., p. 340.

rhage, a circumstance which probably results from the continuance of the traction of the bloodvessels in the line of their course until they suddenly snap in two, whereupon their ends recoil, incurve, and contract at once, so that little or no blood can escape. Similar cases to that related by Cheselden, of "Samuel Wood, a miller, whose arm with the scapula was torn off from his body," with but very little hemorrhage, have since been witnessed repeatedly by other respectable authorities in surgery. Dr. Eve has collected three examples of this injury. In each, the arm with the scapula still attached was plucked completely off from the trunk. In each, also, the lesion was produced in substantially the same manner; the subject was caught by the hand or arm in powerful machinery, and then rapidly dragged upward by that member, until the trunk struck a beam, or a ceiling, which suddenly barred its progress, while the limb continued to move onward in the machine. The hemorrhage was not excessive in either case. It is stated that, in one instance, "the artery was seen pulsating at the bottom of the wound, and was plugged up by a coagulum of blood. The vein was distended, and lay on the torn muscles like a gorged leech." But few ligatures were required, and in one case it seems that no vessel was tied, as "there was no hemorrhage" when the surgeon arrived.¹ But little or no sloughing of the lacerated tissues occurred, and each patient made a good recovery.

Dr. F. Katholitzky relates an excellent example:²—

A man, aged 37, had his right arm and scapula torn away by being caught in a water-barrel which was being drawn up a shaft by steam power. The limb was found in the water at the bottom of the shaft one hundred and thirteen days afterward. Dr. K. saw the patient one hour and a half after the accident. The wound was about twelve inches long and nine wide, and bled but little. *There was no hemorrhage from the subclavian, nor from any of the arteries, and their ends could not be found in the wound.* There was considerable shock. The wound was reduced by means of steel clamps to the size of a hand, and was covered with charpie. Six hours after the casualty, violent pain set in, but was relieved by the subcutaneous injection of morphia. The wound was dressed with iced compresses. During the following days, there was sloughing of portions of tissue, with moderately high fever. Nothing further of importance occurred during the healing of the wound, which was complete at the end of the seventh week. Two years and five months afterwards the patient was in good health, but right-sided scoliosis had appeared.³

But in lacerated wounds, the division of the artery is much oftener found to be incomplete. The Army Medical Museum, at Washington, contains several specimens of this character. One of them was taken from a wound produced by a bayonet-thrust. It shows the subclavian artery torn open for two-thirds of its circumference by the bayonet, one-fourth of an inch from the innominate.⁴ It was obtained from an unknown soldier, killed at Fort Wagner, S. C. This specimen proves that when a large artery is wounded by a bayonet, the breach in its walls is not always of the punctured variety. There is another specimen in the same museum which shows the popliteal vessels lacerated by a splinter of wood.⁵ This injury was inflicted in a railroad accident, October 29, 1864. The patient entered hospital on November 2, and died on the 3d. His thigh was amputated at the junction of the lower and middle thirds. Abernethy relates the case of a man gored in the neck by the horn of a cow. Hemorrhage came on, and was immediately arrested by tying the common carotid artery; but the patient died about thirty hours after

¹ Eve's Surgical Cases, p. 579.

² Allgemeine Wiener med. Zeitung, No. 45, 1873, and New Sydenham Society's Retrospect, 1873-4, p. 278.

³ [Fourteen cases of this injury are referred to in the Article on Amputations, vol. i. p. 654.]

⁴ See Catalogue A. M. M., Specimen 2721.

⁵ Ibid., Specimen 3761.

the operation, it was said from inflammation of the brain. On autopsy, the internal carotid artery was found partly torn across, and the primary branches of the external carotid were found separated from the trunk.¹

Incomplete lacerations of arteries, however, of quite another sort, occur not unfrequently, and, at the same time, are very interesting to surgeons. In these cases the inner and middle coats are torn, while the external tunic remains intact. The lacerated layers of the artery curl backward upon themselves, and may thus completely close the channel of the artery, as happened in the following instance, reported by Professor Verneuil:²—

A man, aged 46, after being thrown from a cart, presented the symptoms of violent delirium, right hemiplegia, and cerebral compression. Externally, only numerous contusions could be found. He died fifteen days subsequently. The autopsy showed complete rupture of the inner and middle coats of the left internal carotid artery, with a clot in its canal extending into the branches of the Sylvian artery. There was extreme softening of almost the whole middle lobe of the left cerebral hemisphere.

In these cases, the lacerated inner and middle coats behave in a manner strictly analogous to that which we have shown above to obtain when these same coats are divided by the pressure of ligatures applied in tying arteries, or by the operation of Dr. Speir's instrument for constricting arteries. In other words, the inner and middle coats of arteries may be torn through by accidents, while the external coat remains entire. In such cases the severed coats curl backward, or recurve upon themselves, exactly as they do in the operation of constriction or crushing of arteries performed with Dr. Speir's instrument for the suppression of hemorrhage, described above (see Fig. 399); and, by their recurvation, these coats may entirely close the lumen of the injured artery.

Again, when in such cases of incomplete laceration of arteries, the recurvation of the inner and middle coats does not suffice to block up the channel of the injured vessel, the pressure of the blood is liable to stretch the outer coat at the place of injury, and expand it into an aneurismal sac, thus furnishing a very interesting variety of traumatic aneurism, as happened in an example recorded by Mr. T. P. Pick,³ in which there was a rupture of the inner and middle coats of the femoral artery, caused by a strain, and followed by a gradual dilatation of the outer coat, and the formation of a traumatic aneurism. Gangrene of the limb set in, and the patient died shortly after amputation at the hip-joint. Digital compression had been previously tried for the cure of the aneurism, and, for a time, with apparent success.

TREATMENT.—In cases where a limb has been torn or plucked completely off from the trunk by the action of machinery, it is generally expedient to tie the principal vessels on the face of the stump. The arteries that project above the surface, or hang out, should always be secured by ligating them with carbolized catgut, whether they bleed or not when the surgeon arrives. The integuments should then be drawn together, and the case treated as an incised wound. A good result has not unfrequently been obtained in these cases by this plan of treatment. As a rule, no tissue is cast off by sloughing or by ulceration, unless it has happened to be badly bruised by striking against some solid body—for instance, a ceiling or a beam.

When a limb has been struck off by a cannon-ball, or a bomb, or any other form of shell, and thus its bloodvessels have been torn in two, it is always advisable to amputate the member at some higher point, if practicable; for

¹ Surgical Observations, vol. ii. p. 72, Am. ed.

² Bull. de l'Acad. de Méd., Jan. 1871; and New Sydenham Society's Retrospect, 1871–2, p. 84.

³ St. George's Hospital Reports, vol. vi. p. 161.

the tissues of the limb are likely to be torn and bruised, or disintegrated and infiltrated with blood, to some distance above the breach, as I once found on examining the ragged-looking stump of a forearm that had been stricken almost off by the premature discharge of a cannon. The tissues of this stump appeared to be but slightly injured, away from the wounded surface, until they were cut into, when they were found to be ecchymosed and disintegrated, as stated above, nearly up to the elbow-joint. The amputation was therefore performed above the elbow, in the continuity of the arm.

Hemorrhage from lacerated wounds that are caused by bayonets, by splinters of wood, by the horns of infuriated animals, or by other means, should in general be restrained by compression until the lacerated vessel itself can be brought into view by making incisions, etc., when it should be tied with carbolized catgut above and below the aperture in its tunics. It should also be divided midway between the two ligatures. When, however, it is impracticable to tie the bleeding vessels at the laceration, the artery from which it springs should be ligated as near the wound as possible. Again, when the parts surrounding the breach are damaged in such a way as to put the preservation of the limb out of the question, or when the peculiar nature or great extent of the injury renders the salvation of the limb impossible, amputation should immediately be performed.

Gangrene of the extremities, when caused by the laceration of arteries, demands that recourse should be had to amputation without delay. When gangrene attacks the toes because the popliteal artery is occluded by the recurvation of its torn inner and middle coats, or because it is torn completely across, the operation should be performed at the knee-joint. When the femoral artery is the seat of the laceration, the operation should generally be performed high up in the thigh, but without permitting any delay to occur in either case. When gangrene attacks the fingers because the axillary artery is torn, the limb should forthwith be amputated near the shoulder.

Aneurisms caused by the laceration of arteries should in general be treated by laying them freely open, scooping out the clots, finding the orifice, and ligating the artery above and below the opening with carbolized catgut, dividing the vessel also midway between the two ligatures. In the after-treatment, antiseptic dressings and drainage-tubes should be employed.

RUPTURES OF SPECIAL ARTERIES.—Femoral Artery.—The main artery of the lower extremity is rent asunder without external wound much oftener than many suppose. In the following example the common femoral artery was ruptured by a strong blow:—

A robust young man, an iron-planer, aged 23, was admitted to hospital, on October 15, with an abrasion of the right groin, and a corresponding swelling of great size which extended upward almost to the umbilicus and downward to the lower third of the thigh. There was no pulsation in the tumor nor in the tibial arteries. He was evidently suffering from extreme loss of blood, being very pallid, and his radial pulse barely perceptible. His injury resulted, half an hour before admission, from being driven by a plane which struck his buttock whilst reversing, and drove him over the "cheek-piece." He was so low that no operative procedure was admissible, and early next morning he died. *Necroscopy* thirty hours after death. The swelling was due to an immense extravasation of blood. The common femoral artery was found completely severed just below Poupart's ligament; its proximal end was filled with a conical clot; its distal end had the external coat tightly twisted beyond the retracted inner and middle coats. Coagulated blood was found in the sheath of the artery up to the common iliac and down to Hunter's canal. The femoral vein contained a clot opposite the place of rupture. The adductor longus and pectineus muscles were also torn across.

Beneath the fascia there was an extensive coagulum which spread in the thigh through the intermuscular spaces to the back of the limb.¹

The cause of death appears to have been "shock," and an extensive hemorrhage from the ruptured femoral artery which was hidden from view by the integuments, but mainly the latter.

The next example shows that the femoral artery and vein may both be torn across when pressed upon by a heavy weight without any corresponding fracture or any perceptible breach of the integuments:—

A man, aged 50, had one wheel of a cart loaded with manure pass over his right thigh. Half an hour afterward he was brought to University College Hospital in a state of extreme collapse; the limb was much swollen and very tense to above the middle of the thigh; foot cold, with motion and sensation in it lost; no pulsation in the tibial arteries. There were scarcely any bruises visible, and the bone was uninjured. Next morning the limb was very livid. There was no increase in the circumference, but the extravasation extended somewhat higher on the inner side. There was no pulsation nor bruit in the swelling. The limb was amputated about two inches below the trochanter; but the patient sank and died soon after the operation. On dissecting the ablated member, all the intermuscular septa were found distended with coagula. On the inner side of the limb, above the popliteal space, there was a large pulpy cavity in which the femoral artery and vein were both found torn completely across; both were plugged by firm coagula at each end. The artery was much contracted for two inches above the rupture, and its torn end was nearly closed thereby. The artery was also atheromatous, and slightly calcified here and there.²

In the following instance there was a rupture involving all the coats of the left femoral artery; but it was cut down upon, the clots were turned out, and both ends were secured by catgut ligatures, with a good result:—

The subject was a collier, aged 30, a patient at the Manchester Royal Infirmary, whose case is reported in the British Medical Journal for August 8, 1874. He ruptured his left femoral artery while straining at his work. He was admitted with a large, diffused, non-pulsatile swelling in the upper part of his left thigh, and no pulsation in the arteries of his leg. From the history of the case, and the condition of the limb, a diagnosis of rupture of the femoral artery was made. Lister's aortic tourniquet was applied, an incision over Scarpa's triangle was made, a large quantity of coagulated blood was removed, and the divided ends of the artery were seen and secured by catgut ligatures. The man progressed uninterruptedly to recovery.

The proper thing to do in cases such as these would therefore seem to be to restrain the inward effusion of blood as soon as possible by digital compression, or by the application of a tourniquet, or Esmarch's elastic ligature, until the seat of the rupture can be laid open by incisions, the clots turned out, and both ends of the artery found and securely tied with prepared catgut. The wound should also receive antiseptic treatment. But, in most cases, the timely restraint of the extravasation of blood into the connective tissue of the limb is a matter of paramount importance; for, if this effusion be not soon suppressed, the patient may perish directly from loss of blood, as happened in two instances related above.

The inner and middle coats of the femoral artery are sometimes lacerated by a blow upon the thigh, whereupon a femoral aneurism ensues from dilatation of the external tunic. Mr. Home has reported the following case which was under the care of Mr. Birch, at St. Thomas's Hospital:—

John Lewis, a negro, received a blow on the anterior part of his right thigh. About a month afterward he perceived a small tumor, which increased; his own expression was that he could feel it *thump, thump*. The tumor appears to have rapidly enlarged.

¹ British Medical Journal, November 22, 1873, p. 603.

² Ibid., July 30, 1870, p. 116.

He therefore came to London, and entered the hospital, Oct. 26.^{*} On examination Mr. Birch found a large pulsating tumor in the femoral region, extending upward to within less than two inches of Poupart's ligament, and occupying two-thirds of the thigh; it was without doubt a femoral aneurism. On Nov. 3, Mr. Birch tied the femoral artery half-an-inch below the profunda; pulsation in the tumor immediately ceased. Gangrene of the sac, however, supervened. On Nov. 14, the tumor burst, and discharged serum and grumous blood; the patient died, in the evening, from septicæmia and secondary hemorrhage. *Autopsy.* The integuments at the middle of the tumor were mortified. The blood contained in the tumor was very putrid. Water injected by the external iliac artery escaped freely from the wound of operation, at the ligature, where the artery appeared to have been opened by ulceration. The laceration of the inner and middle coats from the blow had occurred two and one-half inches below the origin of the profunda. The arterial tunics did not exhibit atheroma or calcification, or any structural degeneration. "The opening where the artery passed out of the aneurismal sac was nearly three inches below the part where it entered."¹

The sac of this aneurism appears to have consisted of the external tunic of the artery, widely dilated, and strengthened externally by adherent laminae of connective tissue.

Another interesting example seems to have been taken from Clarke:—

A man, aged 48, entering hurriedly a badly lighted chamber, struck his left groin with great force against the corner of a table. Ten days afterward, a small tumor, of the size of a pigeon's egg, and at first taken for an enlarged lymphatic gland, appeared at the point contused. This tumor, in three nights, acquired an enormous size; and it pulsated so strongly as to raise the bed-clothes. The tumor sloughed, and burst open, but without hemorrhage. The patient was in the way of cure, when he succumbed to pneumonia. The artery had been torn across.²

In this case the aneurismal swelling, which was formed at first by the gradual expansion or dilatation of the external tunic of the femoral artery at the point where its inner and middle coats had been ruptured by striking against the corner of a table, suddenly gave way without apparent cause; and, in consequence, an enormous swelling, or a so-called diffuse aneurism, soon appeared, from the extravasation of blood into the connective tissue of the thigh; this in turn suppurated and was opened by ulceration or sloughing, but without the occurrence of hemorrhage; the man, however, ultimately died of pyæmic pneumonia.

External Circumflex.—The following case, in which the *external circumflex artery* of the right thigh was ruptured, was under Dupuytren's care at the Hôtel-Dieu; it will prove, from its resemblance to the last in several particulars, of much interest in this connection:—

A man, aged 46, a cook, in running round a table in the kitchen, struck the outer and upper part of his right thigh against an angle of the table. Pain, at the moment of injury, was very acute; twelve days afterward, a swelling of the thigh suddenly rose up (in the space of ten minutes). Leeches and resolvent cataplasms were applied. Subsequently the swelling lessened or increased according to his exact observance of quietude or the reverse. A physician, deceived by the absence of pulsation, made an incision therein two inches long; red blood and coagula were discharged. The wound was immediately closed, and the patient entered the Hôtel-Dieu on November 30. The right thigh presented a tumor which occupied its external and anterior region. The skin over it was rather leaden-hued; there was irregular fluctuation in it, and complete absence of pulsation. The femoral artery and the dorsalis pedis beat normally. Dupuytren announced that the swelling had resulted from the rupture of small vessels, caused by the blow received on the thigh. Diet and resolvents were prescribed. A

¹ The London Medical Journal, 1786, p. 391.

² Nouveau Dictionnaire de Méd. et de Chirurg. pratiques, t. x. p. 471. Paris, 1872.

compressor, however, was kept ready to suppress any hemorrhage that might supervene. December 4, towards evening, two cupfuls of red blood flowed out; the compressor was placed on the femoral artery, and arrested the hemorrhage; five days later it was removed; pus mixed with blood and containing clots was discharged from the wound. December 19, some spoonfuls of blood escaped; there was also mild delirium. December 22, death occurred.¹ At the *autopsy*, a vast cavity containing extravasated blood was found. The external circumflex artery had been ruptured.¹

Rupture of the Popliteal Artery.—This vessel, notwithstanding its sheltered position in the flexure of the knee, not unfrequently sustains a traumatic lesion in the shape of rupture. In the following example the popliteal artery was partially, and the popliteal vein completely, torn across, without external wound:—

A healthy young man, aged 19, while riding on the front seat of an omnibus, was struck on his left knee by the top of a cart drawn by a runaway horse, which drove his knee backward with great force. On admission to hospital, soon afterward, there was much contusion of the knee observed, with swelling in the popliteal space, but no sign of fracture nor of dislocation. The swelling increased, and the patient complained of loss of sensation in his leg; the temperature of the leg also fell, and pulsation could barely be felt in the posterior tibial artery. On auscultation a low clicking sound was heard in the course of the popliteal artery. The diagnosis was a probable rupture of that artery. Primary amputation above the knee was resorted to, and the patient ultimately did well. On examination, there was found extensive effusion of blood into the areolar tissue of the amputated member; the popliteal vein was completely severed; and the inner and middle coats of the popliteal artery were torn through and separated from the external coat, which remained undivided.²

The injury of the knee-joint which complicated the case, and the gangrene of the leg which was strongly threatened, necessitated the performance of amputation. However, if that operation could have been avoided, and the limb saved, a popliteal aneurism would, doubtless, have resulted from this lesion of the artery; and I believe that a similar lesion of the inner and middle coats of this artery, caused by violent stretchings as well as by blows, not unfrequently gives rise to popliteal aneurism, especially when that affection occurs in young persons who have neither atheroma nor calcification in the walls of any bloodvessel. The following case illustrates this point:—

On March 25, 1869, I was called to a young man, aged about 21, of healthy parentage, healthy constitution, and good habits, on account of a popliteal aneurism which had returned several months after being apparently cured by ligature of the superficial femoral artery. The origin of the aneurism could be attributed to nothing but a severe strain, which had probably ruptured the inner and middle coats of the popliteal artery. Flexion treatment had been employed in the summer of 1868, but without benefit; in the autumn, ligature of the femoral had been performed with apparently an excellent result. Early in March, however, the disease had returned; the tumor had increased rapidly. On the 25th, when I was called, it was considerably more than half as large as my fist, and the pain was intense; all the signs peculiar to aneurism were present. Notwithstanding confinement to bed, etc., the tumor continued to increase with great rapidity. His home did not permit of operative treatment, and as the speedy employment of operative measures was imperative, on account of the great size and rapid growth of the swelling, I had him sent to St. Luke's Hospital, on April 12, just nineteen days after I first saw him. There, compression of the femoral artery, both digital and instrumental, was faithfully tried, but without success. The aneurism then appeared almost ready to burst; and, as a last expedient, amputation was performed. He did well for some time; but pyæmia supervened, and, on May 9, caused his death.

¹ Nouveau Dictionnaire de Méd. et de Chirurg. pratiques, t. x. pp. 467, 468.

² British Medical Journal, August 28, 1875, p. 259.

A case of popliteal aneurism, operated on by Mr. James Earle, at St. Bartholomew's Hospital, was also caused by a strain:—

John Smith, aged about 50; he said that about six months before, he had fallen from a scaffold, and that his leg had been caught between the rungs of a ladder, which broke his fall; that he immediately felt pain in the upper part of his leg; that soon afterward it began to swell, and that the swelling had gradually increased to its present size. On examination there appeared a large hard swelling under the heads of the gastrocnemii muscles, reaching up to the bend of the leg. Pulsation was plainly felt in it, and there was no doubt of its being an aneurism. The tumor was now increasing very fast. January 28, 1792, Mr. Earle tied the artery a short distance above the tumor, on Anel's plan; the ligature came away on the fifteenth day, and the man made a good recovery. The case was communicated by Mr. Earle to Home, who published it in the London Medical Gazette. I believe that the violent stretching to which the popliteal artery had been subjected in this case ruptured its inner and middle coats, and thus caused the development of an aneurism.

Rupture of the Anterior Tibial Artery.—In the following example, this vessel was burst open by a blow from a spade, without any corresponding breach of the integuments:—

A laboring man had noticed a slight swelling on his ankle, which gave him no pain, until he struck it a severe blow with a spade one day while at work. Afterward the swelling gradually and continuously enlarged. An explorative incision gave issue only to blood. On operating for the removal of this swelling, it was found to be caused by a wound of the anterior tibial artery, which communicated with an old bursal cyst.¹

By severe blows and by violent strains the posterior tibial artery may be ruptured, just as readily as the anterior tibial, the popliteal, or the femoral; and the treatment should generally consist of bringing into view, by suitable incisions, etc., the ends of the ruptured artery, and securely tying both of them with ligatures of prepared catgut, unless there be some complication present which necessitates amputation.

Rupture of the Brachial Artery.—Malgaigne relates the following case:—

M. Michaux received at the hospital of Louvain a lad of ten years, who had dislocated his elbow backward and outward. There was considerable swelling, but the radial pulse still continued to beat. On the next day reduction was attempted, with assistants. On the third day it was again unsuccessfully attempted; and, in consequence, the elbow became greatly swollen, the radial and ulnar arteries ceased to beat, and the hand lost all color and sensibility. Gangrene ensued; and, six days after the last attempt, M. Michaux performed amputation which saved the patient's life. Examination of the amputated limb showed a rupture of the brachial artery and median nerve.²

The case of a lad, aged 18, who had compound dislocation of the elbow and rupture of the brachial artery, but still recovered, is reported in the *Lancet* of August 8, 1874. The articular surface of the lower end of the humerus protruded through a lacerated wound at the front and inner part of the forearm. The brachial artery was found to be torn across. The case progressed favorably without interruption. At the end of eight weeks the patient was sent into the country with the wound healed, and the elbow ankylosed at a convenient angle.

In the museum of St. Bartholomew's Hospital, Series XIII. 88, there is part of a brachial artery which was torn straight across by external violence. The patient, aged 69, fell with his arm stretched out. At first he seemed little injured; but pulsation was lost in the radial and ulnar arteries. In a few hours the arm became enormously swollen and livid, and amputation near the shoulder was performed.³

¹ British Medical Journal, January 11, 1873, p. 43.

² *Traité des Fractures, etc.*, t. ii. p. 153.

³ St. Bartholomew's Hospital Reports, vol. ii. p. 107.

Pelletan reports the case of Nicolas Pochard, a young soldier, who, from practising the manual of arms with the zeal of a young soldier, acquired an aneurism of the left brachial artery, which was caused by blows or contusions received from the lock of his gun, that were very often repeated until the tunics of the artery gave way.¹

Rupture of the Axillary Artery.—Many examples of this lesion, without any corresponding breach of the integuments, have been placed on record. This accident is very serious, for more than two-thirds of the reported cases have proved fatal. Moreover, it has been produced in many different ways, the most important of which I shall briefly refer to or describe.

Pelletan relates the case of Gabriel Longpré, a journeyman mason, aged about 40, whose axillary artery gave way so that an aneurism formed, in consequence of the violent stretchings to which he subjected it in suspending himself, with all the weight of his body, by the hands, from the pegs of his scaffoldings, from time to time, in order to alleviate the pains of rheumatism.² This case proved fatal.

Mott reports the case of Wm. Haines, aged 28, whom he found, on examination, to have an aneurism of the right axillary artery, as large as a goose's egg, with the following history: "About seven weeks before, he received a violent strain while carrying a canoe on hand-bars across the arms, which was followed by an extensive discoloration of the skin of the right arm, extending to the chest, and attended with considerable pain. Three weeks subsequent to the accident he observed a small swelling, about the size of a pigeon's egg, under the right arm, which had rapidly increased." Mott tied the subclavian artery above the clavicle. The man made an excellent recovery.³

In the museum of the Royal College of Surgeons, Series XXV. 1695, there is an axillary aneurism which was caused by rupture of the axillary artery, from the falling of a man on ice with his arm extended.⁴

Inspector-General Smart, R. N., has called attention to the fact that the axillary artery may be so much injured by the sudden and violent wrench of the shoulder which gunners sustain when explosions occur while in the act of loading cannon, that gangrene of the limb ensues from the occlusion of that vessel. He has also reported three cases in point.⁵ They all occurred from explosions while in the act of ramming home, by which the rammer was expelled, and the arm employed in loading was violently extended. In such cases the artery is injured by the forcible extension of the arm, without puncture or laceration of the integuments.

The injury sustained by the artery often consists of rupturing its inner and middle coats, which then recurve and close the lumen of the artery, whereupon gangrene soon results. Dr. Smart points out that when gangrene appears in such cases, amputation near the shoulder, performed without delay, is the only expedient that can save the patient.

Similar cases of injury of the axillary artery from strains and blows, without any external wound, have been mentioned by Aston Key, Le Gros Clark, Liston, Syme, and Gibbs. Such cases with many interesting examples of various accidents belonging to the same category have been collected and arranged in two tables, by Eug. Boeckel, in the "*Nouveau Dictionnaire de Médecine et de Chirurgie Pratiques*," in the Article *Axillaires (vaisseaux)*, t. iv. pp. 365-9, and 370-74. Paris, 1866.

In the following example, the axillary artery was ruptured by passive movements made for the relief of false ankylosis:—

A woman, aged 40-45, of rather feeble health, had her left shoulder-joint completely stiffened by rheumatic inflammation. On January 10, 1858, about half an hour

¹ Clinique Chirurgicale, t. ii. pp. 14, 15.

² Op. cit., t. ii. pp. 49, 50.

³ American Journal of the Medical Sciences, vol. vii. 1830, pp. 309-11.

⁴ St. Bartholomew's Hospital Reports, vol. ii. p. 107.

⁵ British Medical Journal, September 23, 1871, pp. 342, 343.

after some unusual efforts in the way of passive motion, there came great swelling in and about the axilla, which increased and extended by degrees about the shoulder and upper half of the arm. On January 19, Sir James Paget saw her. She looked pale, feeble, and reduced by the pain. The whole axilla was distended as much as the fixed position of the shoulder would allow, with a tense, firm swelling, raising up in front the pectoralis major, and still more prominently behind the *teres major* and *latissimus dorsi*. Pulsation was distinctly felt in every part of this swelling. A rough, blowing sound was heard all over it, and for a little distance above and below. No pulsation was discernible in the brachial artery or its branches. Pressure on the main trunk above the aneurism abolished the pulsation and bruit. Complete rest, diminished food, and anodynes were recommended, and the policy of delay was continued until April 23, when the increased size of the tumor and other symptoms made an operation imperative. Sir James Paget opened the tumor, under chloroform, by cutting just behind and parallel to the pectoralis major the whole length of the axilla, and by making a second cut at right angles with this, commencing at its middle, through the pectoralis major muscle, straight upward, its whole width. Raising the angular flaps of the \perp shaped wound of operation, the surface of the great mass of the clot was exposed. Two small arteries that were cut were tied. The clots were scooped out and an oval-shaped aperture one-fourth of an inch long by one-tenth of an inch wide was found in the posterior wall of the axillary artery. Above and below it the vessel appeared sound. Ligatures were applied above and below the aperture, and the vessel itself was divided between them. The loss of blood during the operation was under six ounces. The cavity of this aneurism was the anatomical axilla exactly filled and distended. The patient made a good recovery.¹ I have taken space to give all the steps of this important operation, and almost any surgeon who is about to undertake its performance will concede the value of Sir James Paget's method, and probably wish for greater fulness of detail.

Dislocation of the arm at the shoulder-joint is sometimes attended by rupture of the axillary artery, without any external wound. In other words, the same force that displaces the head of the humerus, rends the accompanying artery also, as happened in the following instance, related by Dr. R. Adams:—²

John Smith, aged 50, was thrown down by a runaway horse. About ten minutes afterward he was brought to the Jervis Street Hospital "in a cold perspiration, pallid, and apparently on the verge of syncope." The left humerus was found to be dislocated into the axilla. The artery accompanying it was also ruptured; blood was extravasated into the axilla, and there was corresponding tumefaction or diffused aneurism; no pulse in radial and ulnar arteries. Dr. Adams easily reduced the dislocation, which he proceeded to do at once, while the man was still prostrated by the "shock," and by the concealed hemorrhage. Ten days later, Mr. O'Reilly tied the subclavian artery. The man recovered and lived many years.

Nélaton states that, although rupture of the axillary artery in consequence of dislocation of the shoulder is very rare, he has observed a remarkable example, attending a displacement below the glenoid cavity. The two inner tunics of this vessel were torn to a very small extent; a false aneurism resulted, that grew rapidly, and obliged him, three months later, to resort to ligation of the subclavian artery, which he practised above the clavicle; but the disorder had already made so alarming a progress that, notwithstanding the ligation, the aneurismal cyst burst open, and entailed a sad termination from secondary hemorrhage.³ Elsewhere, I find it stated that the patient was a woman, advanced in years; that the aneurism communicated with the cavity of the joint; and that the reduction was easily effected. From the last-mentioned circumstance, Nélaton probably inferred that the laceration

¹ St. Bartholomew's Hosp. Reports, vol. ii. pp. 103-106.

² Cyclopædia of Anatomy and Physiology, article "Shoulder-joint," pp. 616, 617.

³ *Éléments de Pathologie Chirurgicale*, t. ii. p. 368.

of the artery occurred in connection with the displacement of the caput humeri, just as it did in Dr. Adams's case, related above.

Professor A. Bérard has observed in connection with a dislocation of the humerus under the coracoid process, a rupture of the two inner tunics of the axillary artery, extending through its whole circumference; the external tunic was stretched out as a slender tube. This lesion was attended by obliteration of the vessel, and gangrene of several fingers, and, finally, by the death of the patient. The absence of pulsation in the radial and ulnar arteries made M. Bérard suspect a lesion of the axillary artery.¹ In this case, doubtless the ruptured inner and middle coats recurved, so as to close the channel of the artery.

Moreover, Malgaigne has shown that rupture of the axillary artery has occurred in connection with most of the common forms of dislocation at the shoulder.

In some cases, however, where dislocation of the humerus has been thought to be present, the axillary artery has been found torn by the splinters or fragments attending a fracture of the humerus, there being no dislocation whatever of that bone. The following examples in point have occurred in the practice of two very eminent surgeons:—

A man fell and injured his shoulder. The surgeon who first saw him said there was a dislocation, and tried to reduce it. Being not quite satisfied with the result, for the head of the humerus still appeared to project in front more than it ought to do, he sent for Mr. Stanley, who thought it might be a case of partial dislocation forward (much spoken of at the time by Mr. Abernethy). Accordingly, they bound the arm tightly across the chest, with the hand resting on the opposite shoulder. Calling a few days afterward, Mr. Stanley's attention was aroused by the fact that there was no pulse at the wrist of the injured arm. The bandage was immediately removed, but without restoration of the pulse. Many years later, the man died, and Mr. Stanley carefully examined the part. He found that there had been a fracture through the anatomical neck of the humerus, with obliteration of the axillary artery opposite thereto.² Mr. Callender, in commenting on this case, fancies that the inner and middle coats of the artery only had given way, as in Bérard's case, which I have just presented—where, however, the obliteration of the artery was followed by death from gangrene; and his view of the case is probably the correct one.

Mr. Skey³ met with the next example: A woman, aged 55, slipped in walking, and fell violently to the ground, with her arm in an extended position. A day or two afterward she was seen by a surgeon, who detected and reduced, it was said, a dislocation of the shoulder. Three or four weeks after that, she began to complain of a swelling in the armpit, which appears to have slowly increased. Two months later, some blood escaped. Then she was sent to St. Bartholomew's Hospital and admitted under Mr. Skey's care, three months subsequent to the fall. After careful consideration, the swelling was laid freely open, the blood turned out, and the axillary artery tied above and below the aperture in its walls. Subsequently, the patient died; and, on *autopsy*, the humerus was found obliquely fractured in its upper third; the wound of the artery had been caused by a pointed piece of detached bone. There had been no dislocation.

The procedures for reducing dislocations of the shoulder-joint, especially for reducing those which have existed some considerable time, are quite liable to tear the walls of the axillary artery, and many examples of this accident have been placed on record. In some of them its occurrence has speedily been followed by death from shock and hemorrhage, as it was in the following case that was treated by Professor Gibson:—

A man, aged 50, presented himself with a luxation of the right arm, of two months' standing. Three weeks after the accident, it was said, four strong men had pulled on

¹ *Éléments de Pathologie Chirurgicale*, t. ii. pp. 368, 369.

² *St. Bartholomew's Hospital*, vol. ii. pp. 102, 103.

³ *Ibid.*, p. 102.

the arm without effect. Five weeks subsequently he was bled to the amount of twenty-four ounces, under Gibson's direction, and attempts at reduction were made, first with pulleys, then with five or six assistants; but, the patient becoming faint, these efforts were discontinued. Already a considerable axillary swelling was apparent, when, after two slight rotary movements, the head of the humerus suddenly slipped into its place. But the artery having been torn across, the swelling rapidly increased, the patient became blanched, and died some hours after the operation. On *autopsy*, the axillary artery was found torn directly across and separated from its connections, and there was a great quantity of coagulum in the axilla.¹

Delpech's case of the mayor of Nîmes belongs to the same category: While he was reducing a luxation of the arm, in this case, the extension was made by six assistants; at the moment of reduction, the patient turned pale, lost consciousness, and did not recover it; he was dead. The cause of death was rupture of the axillary artery, according to M. Rigal, who was one of the six assistants, and mentioned the fact to Malgaigne.² The axillary region is capacious, its connective tissue very loose, and, therefore, when the axillary artery is opened subcutaneously, blood may be effused with great rapidity, and in great quantity; and this concealed hemorrhage may, if disregarded, and if the patient be kept in an upright posture, readily prove fatal.

Professor Lister has had a case where concealed hemorrhage of this sort occurred, and the accident proved quickly fatal:—

A man, aged 58, had dislocation of the shoulder, of seven or eight weeks' standing. Reduction was attempted by manipulation, and subsequently by pulleys, no undue force being exerted by either method. During the attempt a sharp crack was heard; a swelling appeared on the dorsal and posterior part of the scapula, which ultimately reached the size of an adult's head; it was due to a rupture of the axillary artery, with extravasation of blood into the surrounding structures. Without hesitation, Professor Lister cut down on the spot, and searched for the ruptured vessel. An aperture was found in the posterior part of the axillary artery, and a ligature was applied on each side of it. The patient rallied, but died about three hours afterwards. *Necroscopy* showed that the humerus had a small spiculum of bone attached to its shaft, which was the immediate cause of the rupture. The artery itself was very atheromatous.³ A tumor of this description, as large as a man's head, would require for its production the loss to the circulation of an immense quantity of blood, enough to produce unaided in most cases anæmic exhaustion of a fatal nature.

Verduce⁴ saw in a reduction of the humerus at the shoulder, the axillary artery torn, and, in consequence, an aneurism which speedily proved fatal. Petit⁵ witnessed a similar accident. Platner⁶ cites a case of rupture of the axillary artery and vein, in consequence of violent extension; which, doubtless, proved speedily fatal. Sir A. Cooper mentions a case of dislocation at the shoulder-joint, in which reduction was easily effected, but a false aneurism formed; and, the sac bursting, a fatal hemorrhage ensued.⁷ The artery was found diseased and rigid. Mr. Rivington records the case of a man, aged 71, who died in consequence of hemorrhage from a traumatic aneurism of the axillary artery, that resulted from the reduction of a dislocated humerus.⁸ The aneurism burst.

The sad result in each of these eight cases shows how great the danger of death from hemorrhage really is when the axillary artery chances to be torn

¹ Institutes and Practice of Surgery, vol. i. pp. 325–9.

² Traité des Fractures, etc., t. ii. p. 152.

³ Medical Times and Gazette, February 1, 1873.

⁴ Malgaigne, Traité des Fractures, etc., t. ii. p. 151.

⁵ Ibid., p. 151.

⁷ On Dislocations and Fractures of the Joints, p. 371.

⁸ Brit. Med. Journal, April 20, 1872.

⁶ Ibid.

in efforts for reducing dislocated shoulders; and, inasmuch as death may speedily follow the rupture from sub-tegumentary hemorrhage, as well as remotely from bursting of the aneurismal pouch, and external hemorrhage, the first indication in the treatment of these cases is plainly to restrain the flow of blood in the torn vessel by compressing digitally the subclavian artery against the first rib, as soon as the axillary swelling begins to appear, and by continuing the compression until the place of rupture can be exposed to view by incisions, and till the artery itself can be secured with catgut ligatures above and below the point at which it has given way.

This accident is also liable to be followed by gangrene. For example, Professor Gibson has reported the following case:—

A man, aged 35, with a dislocation of the left humerus of nine or ten weeks' standing, for which four attempts at reduction had been made, was the patient. Severe operative measures were employed, and, after an hour and three-quarters, the bone snapped into the glenoid cavity. At 8 o'clock next morning, an axillary swelling with characteristic pulsation was observed. The swelling increased, and at 3 P. M. next day, fifty-four hours after the reduction, the subclavian artery was tied, and the tumor ceased to pulsate. The limb, however, became gangrenous, and, on the sixth day after the operation, the man died.¹ The inner and middle coats of the artery were found torn across and separated for half an inch, and the external coat was dilated into an aneurismal sac, dating probably from the luxation itself, or from the previous attempts at reduction; during the last attempt the sac was torn open from behind, and an enormous effusion of blood entered the joint through the torn capsule. The rim of the glenoid cavity was fractured anteriorly.

In the British Medical Journal, May 18, 1872, is recorded the case of a man, aged 38, who dislocated his humerus and had it reduced. He was then admitted into the Northampton Infirmary. Gangrene of the arm ensued, and the man died. Fracture of the coracoid process, chipping of the head of the humerus, and rupture of the axillary artery, were found.

Flaubert has reported the following case which occurred in the practice of M. Leudet:—

A sailor, aged 57, was admitted to the hospital at Rouen, with a dislocation of the arm forward, of eleven days' standing. Extension was made by eight intelligent pupils, and, on the second attempt, the reduction was effected. But, just before relaxing the extension, the patient became pallid, his radial pulse ceased to beat, and an enormous swelling rose up under the great pectoral muscle. There was intense pain with pulsation in the tumor, and the whole arm became cold and livid. Gangrene little by little took possession of the limb. On the fourteenth day the aneurism burst in two places, and, an hour afterward, the patient died. The axillary artery was found torn completely across a little above the origin of the scapular. The pectoralis major and the coracoid portion of the biceps muscles were also extensively lacerated. The rim of the glenoid cavity, too, was broken.²

This accident is sometimes attended by death from exhaustion. For example, Mr. De Morgan, in a clinical lecture,³ relates the case of a man, aged 54, who came under his care a fortnight after the reduction of a dislocation of the shoulder, under chloroform, with the heel in the axilla. Extravasation of blood into the axilla occurred, and increased. The man's strength failed, and he got rigors. Mr. De Morgan laid open the swelling, turned out the clots, etc.; but the man continued to sink. At the *necroscopy* it was impossible to detect the source of the bleeding. Anæmic exhaustion arising from loss of blood in the form of a concealed hemorrhage, however, is one of the most important causes of the deaths which result from this lesion.

¹ Am. Journ. of the Medical Sciences, pp. 136–141.

² Malgaigne, op. cit., t. ii. p. 153.

³ British Medical Journal, January 6, 1872.

The axillary artery may possibly be torn across in striving to reduce dislocations of the shoulder, in such manner that the bleeding may spontaneously cease, that the extravasated blood may undergo absorption, and that a cure may thus ensue, without operative interference. I believe that this fortunate occurrence is exemplified by the history of the following case:—

Professor H. B. Sands¹ was called to a lady, aged 86, seven or eight weeks after her right shoulder had been dislocated downward. Soon afterward it had been reduced. About ten days later, however, the dislocation was reproduced, and it remained in that state until Professor Sands's visit. The patient was etherized, and a very moderate effort was made at reduction. While arranging for a second attempt, five or six minutes subsequently, Dr. Sands thought he perceived a swelling in the axilla. He removed the sheet; it was very apparent that a bloodvessel had given way; there was a quite rapid increase of the swelling in the axillary region, and it was very soon as large as the head of a child at term. There was no pulsation in the radial, ulnar, or brachial artery. Nothing in the way of treatment was done, except to place the arm by the side and apply a bandage; but within half an hour the skin of the axilla had begun to show discoloration, and within a few hours the discoloration was very marked, and extended up to the shoulder. The patient was excessively prostrated by the accident, and at one time it seemed not improbable that she would die from syncope. Hypodermic injections of brandy were given, and brandy by the mouth as soon as it could be swallowed, but she remained in a very low condition for some time, especially at night. In the course of the next day after the accident, the extravasation gave signs of its presence quite distinctly, upon the side of the chest; and afterwards it could readily be seen on the side of the trunk as low as the pelvis. The discoloration behind covered nearly the entire scapular region. There was neither fluctuation nor murmur over the extravasation. There had been gradual improvement, and although pulsation had not returned in any of the arteries, the limb itself presented no unfavorable appearance. The patient made no special complaint, excepting a very uncomfortable tingling, at times along the distribution of the ulnar nerve. Professor Sands thought that no vessel except the axillary artery was ruptured, was surprised that the rupture should occur from the use of so little force, and was gratified at an unexpected recovery from so dangerous an accident.

The rapidity and copiousness with which the blood was effused in this case indicate that some large vessel was opened; the disappearance or cessation of the pulse in the radial, ulnar, and brachial arteries, together with the site of the tumefaction itself, shows that the axillary artery was the vessel ruptured. And, were the axillary artery completely torn across in this case, it was quite within the range of possibility for the ragged ends to become permanently closed by the contraction and retraction of the torn tunics of the artery, supplemented by the formation of a conical plug from coagulum in each end thereof, which would become organized. The natural hæmostasis in such cases is, no doubt, aided considerably by fastening the arm to the trunk with a broad roller.

The swellings appearing suddenly in the axilla during attempts to reduce old dislocations of the shoulder-joint, which the French surgeons formerly called *tumeurs aériennes*, and which usually ended in recovery without operation, were not unfrequently due to rupture of the axillary artery. The following example of *tumeur aérienne* occurred in the practice of Desault:—

A man, aged 60, came with a dislocation of a month and a half's standing. The reduction was scarcely achieved when a tumor was suddenly seen to rise up under the great pectoral muscle, and extend itself towards the armpit, occupying finally its whole extent. The pulse on the affected side became scarcely perceptible, and the man fell into a syncope. Desault himself at first feared that the axillary artery was ruptured. Methodical pressure was applied to the swelling by means of compresses and a bandage, which, at the same time, kept the arm fixed against the trunk. That night, acute pain

¹ Medical Record, January 10, 1880.

about the shoulder and the tumor came on; next day, high fever also appeared; on the third day they left. The swelling likewise abated, and, by the fifteenth day, had entirely disappeared. There still remained, however, a very extensive ecchymosis; but its resolution was complete on the twenty-seventh day.¹

Considerable light is thrown upon the real nature of the lesion which existed in this case by what happened in a precisely similar case related by Pelletan,² the tradition of which had been preserved at the Hôtel-Dieu for almost twenty years. Whilst violent efforts to reduce a dislocation of the humerus, of four months' standing, were being made, a painful tearing occurred, and a large-sized tumor rose up. This tumor was declared to be emphysematous. It was opened by an incision; and the patient died of hemorrhage. Some of the eye-witnesses informed Pelletan that there was a rupture of the axillary artery with extravasation of blood. Had the incision not been made, the patient would probably have recovered.

Malgaigne relates another case which ended in recovery, without operation:—

A carman, aged 44, dislocated his humerus forward under the clavicle, and after suffering numerous unsuccessful attempts to reduce it, came to Malgaigne, who, on the sixty-eighth day, also attempted its reduction, and success seemed assured when he saw the subclavian hollow suddenly elevated by a tumefaction which almost visibly overran the axilla and part of the shoulder. Percussion gave a dull sound. Auscultation revealed nothing. The radial pulse continued to beat. The attempt at reduction, however, was at once abandoned, in order to avert the danger. The arm was immovably fixed against the side, and the tumor was covered with ice. Some hours later, the growth of the swelling seemed to be arrested. Soon afterwards, an enormous ecchymosis appeared. On the ninth day absorption had begun; and, on the twenty-second day, the tumor and the ecchymosis had vanished.³

Malgaigne thought that, inasmuch as the radial pulse was not affected, the axillary artery was not opened; but this circumstance only shows that the canal of the axillary artery was not obstructed. Recovery in such cases takes place without the obliteration of the canal. In one case, analogous to the above, Scarpa observed that the wounded edges of the artery had adhered, and that a mere line of cicatrization was discoverable when the artery was slit open. The coagulum, shut out in this manner from the canal of the vessel, formed a tumor which was attached to the outside of the artery.⁴ Hodgson, also, remarks that "an aneurism arising from a punctured artery sometimes becomes filled with lamellated coagulum, which seals up the orifice through which the sac communicated with the artery, and the cure of the disease is accomplished without the canal of the artery being obliterated; the coagulum is absorbed, the sac contracts, and the orifice in the artery is permanently closed;"⁵ and, in support of this view, he cites observations recorded by Saviard, Petit, Foubert, Scarpa, and Jones. It is obvious that when a rupture of the axillary artery is cured by Nature in either of these two ways the radial pulse may remain unaffected throughout.

Symptoms and Diagnosis of Rupture of Axillary Artery.—The phenomena which indicate that the axillary artery is ruptured, are those that arise from a rapid and copious effusion of blood into the loose connective tissue of the armpit, namely, a swelling appearing suddenly in some part of the axillary region, increasing quickly to a great size, so as to fully occupy that locality, and attended soon by discoloration of the integuments with infiltrated blood; the general signs of hemorrhage are often present, for instance, pallor of coun-

¹ Œuvres Chirurgicales, t. i. pp. 379, 380.

² Clinique Chirurgicale, t. ii. p. 95.

⁴ Hodgson, Diseases of Arteries, pp. 489, 490.

³ Op. cit., t. ii. p. 150.

⁵ Ibid., pp. 488, 489.

tenance and lips, weak, rapid, or scarcely perceptible pulse, and great debility with marked faintness, or even complete syncope. The characteristic symptoms of aneurism, however, are very frequently absent, as the examples of this accident, which have already been presented, fairly show; for in many of them there was neither pulsation in the tumor, nor aneurismal thrill, nor aneurismal bruit, nor even circumscribed tumefaction. When the aperture in the artery is very small, or when the laceration does not at first extend through all the coats of the artery, the swelling may come on very slowly or very irregularly; and this circumstance, together with the absence of the symptoms which characterize aneurismal tumors, has led surgeons of deserved eminence into errors of diagnosis that have been attended with disastrous consequences. The following case, reported by Mr. Callender, illustrates in a useful manner the symptomatology and some of the difficulties which may attend the diagnosis of this accident:—

A gardener, aged 61, dislocated his left shoulder-joint by a fall. The luxation was reduced; but, from employing passive movements too soon, it recurred. At the beginning of the seventh week, Mr. Callender again reduced it, under chloroform, by circumduction, "with the exercise of very slight force." Immediately afterward, "a swelling, rapidly lifting itself and projecting the pectoral muscle," attracted his attention. It did not pulsate, and the radial artery beat naturally. He erroneously thought the main artery was not injured; "so the arm was confined by a bandage and the patient was removed to his bed." "The swelling having attained considerable size ceased to grow larger, and, as the man recovered from chloroform, there was no complaint of local pain." "The following morning, the patient's general condition was good." "The swelling beneath the pectoral muscle had become more diffused," "so that it extended around and behind the shoulder." "There was considerable ecchymosis," "as low as the buttoek," "and the entire arm was cedematous." "No change occurred, save that the ecchymosis began to clear up," and the œdema of the arm was rapidly subsiding, until the fourth day. "Then, after straining at stool, he complained of pain about the shoulder, and it was evident that blood had been freshly effused." "The radial and ulnar arteries continued to beat normally." During the next thirty-eight days, the tumor "did not materially increase in size. But now it again enlarged itself." "As before, no pulsation existed in the swelling, nor was any bruit detected, carefully as it was naturally sought for." The confinement to bed and the local mischief were beginning to tell on the patient; it was decided to operate, about six weeks after the reduction of the luxation. An incision was made along the outer border of the pectoralis major, and was intersected by another, at its middle, extending inward through the whole thickness of the muscle, as high as the clavicle. When the great cavity thus opened was cleared of blood, some clots were seen projecting from behind the pectoralis minor. On removing them with a finger, a gush of arterial blood immediately followed. This bleeding was readily checked by compressing digitally the subclavian artery as it came over the first rib, and the distal portion in the lower part of the opened cavity. The pectoralis minor was then cut through, and it was seen that the bleeding came from a small, roundish aperture in the upper wall of the artery, and by pressing on this spot all hemorrhage was arrested. The vessel was next more completely exposed, and a ligature was passed around it on the distal side of the aperture, and then tied. A second ligature was placed on the vessel, about one inch above the first, and the artery itself was cut across midway between them. The walls of the vessel were considerably thickened. The principal veins and nerves were uninjured. For four days the patient did well. On the fifth day, the arm became gangrenous. On the afternoon of the seventh day, he died suddenly with symptoms of pulmonary embolism."¹

Had a correct diagnosis been made at the outset of this case, and had a plan of treatment consisting of adequately compressing the subclavian artery upon the first rib, and likewise the tumor itself, and confining the arm to the chest

¹ St. Bartholomew's Hospital Reports, vol. ii. pp. 96-100.

by means of a broad roller, been judiciously carried out from the beginning, it is not improbable that the issue of the case would have been favorable.

The following example will serve to illustrate still further the symptomatology of this accident, and the errors of diagnosis which may attend it:—

A woman, aged 66, sustained a dislocation of the shoulder, which, at first unrecognized, was reduced at the end of six weeks by a “bone-setter,” who made extension by the elbow and wrist, with the aid of four strong men. The arm remained engorged, and two or three months after the accident the patient entered the Hôtel-Dieu. Twelve days after admission, she received from another patient a blow on the elbow, which determined the appearance of a tumor in the axilla, of the size of an almond; and a pupil, who examined her at this time, found the radial pulse already absent. Six or eight days later, the swelling having increased, Dupuytren mistook it for an abscess; he thrust a bistoury into it, saw a jet of arterial blood escape, and, on making a better examination detected an obscure thrill in the tumor. He proposed to ligate the sub-clavian, a bold idea for the period (1810), but Pelletan would not allow it to be executed. Valsalva’s plan of treatment was essayed; an eschar formed on the tumor, a hemorrhage completed the patient’s exhaustion, and she died eight days after the puncture, and fourteen days after the appearance of the aneurismal tumor. On *autopsy*, the outer coat of the axillary artery was found dilated, through a space two inches long, to a diameter of one inch, where widest. This dilatation presented on its posterior, external aspect, an aperture which opened into the cavity of a very much larger swelling, equalling at least the size of a new-born infant’s head, and having cellular tissue only for its wall. Above the dilatation, the artery was dry and hard; below, its canal was completely obliterated.¹

It is probable that the employment of violent extension, in this case, was attended with rupture of the inner and middle coats of the axillary artery, and followed by dilatation of the outer coat into an aneurismal pouch; that the blow on the elbow made a small rent in this pouch, and led to an effusion of blood into the connective tissue of the armpit, which Dupuytren punctured because he thought it to be an abscess. Exploration of the tumor with the grooved needle, or even a critical examination of the tumor by ordinary means, would have prevented this sad mistake.

The sudden formation of a large swelling in the armpit, in consequence of a lesion of the axillary vessels resulting from a blow, or from a strain of the shoulder, or from violent extension of the arm, or from dislocation of the arm at the shoulder-joint, or from efforts to reduce this form of dislocation, is but seldom due to anything beside a rupture of the axillary artery. When such a swelling pulsates and presents the thrill and bruit of an aneurism, there is, of course, no difficulty whatever in determining its true character. But this is not often the case. Generally such swellings have neither pulsation, nor thrill, nor bruit. When, however, pulsation ceases in the radial, ulnar, and brachial arteries, simultaneously with the injury and the appearance of the axillary swelling, it is indicated with sufficient clearness that the continuity of the axillary artery as a canal or tube has been destroyed by the accident, or that the lumen of the vessel has been filled up by the lesion. When pulsation continues in the arteries of the forearm and arm, notwithstanding the tumefaction in the axilla, we must bring to our aid, in order to determine the nature of the tumefaction, the situation and extent of the subcutaneous ecchymosis, the gravity of the general signs of hemorrhage, the shape of, and degree of tension in, the axillary swelling itself, and a recollection of the fact that there are but three or four cases of uncomplicated rupture of the axillary vein on record, and that it is an accident of extremely rare occurrence. Moreover, when such a swelling is

¹ Pelletan, Clinique Chirurgicale, t. ii. p. 83; Dupuytren, Leçons Orales, 2me éd. t. iil. p. 12.

due to rupture of the axillary vein, it is likely to be much less tense and rounded than when it is due to rupture of the axillary artery. The continuance of the radial pulse when the axillary artery is torn open, denotes that its coats are perforated by a small aperture, that its canal remains open, and that possibly a cure may be effected by compressing the main artery on the cardiac side of the swelling, and by binding, at the same time, the arm to the trunk with a broad roller.

Treatment.—Sir Charles Bell relates that, at the infirmary of Newcastle, strong efforts to reduce a dislocation of the shoulder ruptured, at the same time, the muscles and the axillary artery, so that it was necessary to resort to immediate amputation.¹ The operation failed to save the patient. Syme, however, has amputated in three cases where the axillary artery had sustained a rupture, with success in each instance; and in cases where gangrene follows this accident, amputation in the upper third of the arm, or at the shoulder-joint, is almost our sole expedient.

Warren tied the subclavian artery successfully in the following instance:—

A man, aged 30, dislocated his shoulder whilst drunk. The reduction was immediately effected with the operator's boot in the axilla. A tumor formed in the armpit; forty-three days afterward it broke open, and two hemorrhages ensued. The subclavian artery was then tied in the third part of its course, and the life of the patient was saved.²

In the cases operated on by Mott and O'Reilly, which I have already presented, ligature of the subclavian artery was also followed by recovery. But in another case that was operated on by Nélaton, also presented above, ligature of the subclavian artery in the third part of its course was followed by bursting open of the aneurismal pouch, and by death from secondary hemorrhage. Furthermore, Panas has reported a case of axillary aneurism which supervened fifteen days after reducing a dislocation of the left shoulder. He tied the subclavian artery, external to the scaleni, but, three months afterwards, the patient died from suppuration of the aneurismal sac. The *autopsy* showed that the rupture had involved mainly the inner and middle tunics of the artery, and that it had occurred near the origin of the subscapular.³ These cases of Nélaton and Panas clearly show that ruptures of the axillary artery, when treated by ligation of the subclavian in the third part of its course, are very liable to be followed by bursting open of the axillary swelling, and by death from secondary hemorrhage or from suppuration of the aneurismal cavity.

Blackman tied the axillary artery, in the first part of its course, without benefit, in the following case:—

A physician, aged 50, presented himself with a dislocation of the shoulder downward and inward, of sixteen weeks' duration, one unsuccessful attempt at reduction having been made ten weeks after the accident. Chloroform and ether (mixed) having been administered, the arm was adducted, rotated, abducted, and elevated; these manipulations having been continued about ten minutes, tumefaction appeared in the pectoral region, which in a few minutes attained considerable size, and it was then found that the radial and ulnar arteries had ceased to pulsate. Rupture of the axillary artery was diagnosed. The axillary itself was then tied in the upper part of its course, but the patient died on the twelfth day from secondary hemorrhage, occurring at the seat of ligation.⁴ The untoward result in this case shows very clearly, I think, how badly adapted the operation of Anel is for affording relief in all similar cases.

¹ Malgaigne, *Traité des Fractures*, etc., t. ii. p. 151.

² American Journal of the Medical Sciences, 1846, vol. xi, p. 539.

³ Nouveau Dictionnaire de Médecine et de Chirurgie pratiques, t. xiii. pp. 492, 493. Paris, 1870.

⁴ Hamilton, *Fractures and Dislocations*, p. 657.

Sir James Paget, in a case of rupture of the axillary artery which I have already presented, laid the tumor freely open by a **T**-shaped incision, scooped out the clots, found an oval-shaped aperture in the posterior wall of the artery, ligated the artery on each side of the aperture, and divided the vessel itself midway between the two ligatures. The loss of blood attending the operation was less than six ounces. The patient made a good recovery. By the same procedure, which is in substance the "old operation," Syme also treated with success two cases belonging to the same category. In such cases this method of operating should generally be preferred, because it is much less liable to be followed by secondary hemorrhage and suppuration of the sac than ligation of the subclavian artery in the third part of its course, or ligation of the axillary artery itself in the first part of its course. In performing the "old operation," the distal ligature should generally be applied before the proximal, because the flow of blood from the distal portion of the artery is apt to give the surgeon much more trouble than the hemorrhage from the proximal portion. The surgeon may, indeed, be strongly tempted to tie the subclavian artery in the third part of its course, on account of the comparative ease with which this operation can be performed, instead of cutting down upon the seat of the rupture, and tying the artery above and below it; but if he listen to this prompting of indolence, he may live to sorely regret his failure to employ the more difficult procedure.

Compression of the main artery on the cardiac side of the lesion has not, I believe, received that degree of attention in cases where the axillary artery is ruptured without external wound, and blood is being poured in great quantity into the loose connective tissue of the armpit, which its importance as a hæmostatic measure really demands. In the foregoing pages I have briefly presented thirty-four cases in which there was a rupture of the axillary artery. Twenty-six of them ended in death, and only eight in recovery; and in four of these successful cases, no treatment whatever was employed, excepting compression, with fixation of the arm to the side of the trunk by means of a bandage, and quietude; and in one instance the application of ice. When, therefore, the surgeon has the misfortune to witness the occurrence of this accident, he should immediately proceed to compress the subclavian artery against the first rib, for by so doing he will restrict the extravasation to a moderate amount, and may even effect a permanent cure. By this means he can at least prevent the concealed hemorrhage from going so far as to produce a fatal syncope in a short time, or anæmic exhaustion and death therefrom in the course of a few days. In most instances of extravasation from rupture of the axillary artery, as soon as the diagnosis becomes clear, the best course for the surgeon to pursue is, while continuing the pressure on the subclavian artery, to cut down upon and expose the axillary artery where it is lacerated, and to place a carbolized catgut ligature around it on each side of the laceration, finally dividing the vessel itself midway between the two ligatures. But when the surgeon is not called to the case until a great extravasation has already occurred, and the armpit is hugely distended with effused blood, the patient at the same time being cold, pallid, and almost pulseless from shock and hemorrhage, vigorous pressure should instantly be applied to the subclavian artery, and continued unceasingly, in order to prevent the further effusion of blood, until such time as the patient may have reacted sufficiently to allow the performance of the operation. Whenever a great extravasation of blood has occurred in consequence of this lesion, no operative procedure except the old one, or amputation at the shoulder, should be employed; and generally in such cases the cure should be attempted by compression supplemented by the "old operation." And, inasmuch as this operation is not always easy of performance, the surgeon will probably succeed best by thor-

oughly and faithfully compressing the main trunk on the cardiac side of the lesion, keeping the arm at the same time fastened to the chest by a broad roller, unless he possesses more than ordinary ability for operating on blood-vessels, and has the aid of at least one assistant, who is almost as competent as himself for such undertakings.

When, however, the laceration being but slight and restricted to the inner and middle coats of the axillary artery, the aneurismal tumor is developed but slowly, and has not yet attained a very considerable size—while it is also quite circumscribed, and has a genuine sac or a well-defined wall consisting of the external tunic of the artery, strengthened outwardly by laminae of condensed connective tissue—it may be expedient to tie the subclavian artery in the third part of its course on the plan of Hunter, as was practised by Mott with success in a case which I have already presented. But in all cases where the tumefaction is very great, or is caused by extravasation of blood into the connective tissue of the armpit, the only plan of ligation admissible is the “old operation,” whereby the clots are all taken out, and the artery itself is secured on each side of the laceration, and also divided midway between the two ligatures; for when this procedure is employed in such cases, the liability to death from secondary hemorrhage, or from suppuration of the sac, becomes very much less than it would be were Hunter’s or Anel’s operation performed. Furthermore, the surgeon should never make haste to use the knife so much as to ignore the diagnostic signs of this lesion; and in their absence he should place his main dependence on compression.

Before quitting this subject it will be useful for me to point out the principal methods by which compression may be successfully applied to the subclavian artery for the cure of axillary aneurism; and I cannot do this more clearly and tersely than by presenting a few examples in point:—

A man, aged 71, under the care of Mr. Erichsen, in whom the aneurismal tumor had been noticed only one month, had compression applied for twenty-five hours—digital compression for eleven hours and mechanical for fourteen. The treatment extended from June 23 to August 12, and resulted in cure.¹

Mr. Cooper Forster also records a case. Pressure (digital and with a key) was applied to the subclavian, at intervals, for three days, with some benefit; and then, under chloroform, with a key above the clavicle, for five and a half hours, with complete success. It was, however, continued three hours longer.²

M. Verneuil³ had under his care a man suffering from an aneurism in the left axilla, having a diameter of about three and a half inches. First the arm was carried backward, pronated, and adducted, and fastened in this position to the thorax, but the patient could not bear this position of the limb any considerable length of time. Then digital compression of the subclavian artery (above the clavicle) was continued for twenty-four hours, but had to be abandoned, as the assistants became fatigued. A thick plaster of gypsum was now laid in the supra-clavicular region, and digital compression was made through it until the plaster had become hardened. From the model of the part thus obtained, a leaden cast, weighing six and a half pounds, was made, and it was used for effecting compression of the subclavian, its potency being increased by means of a handle. The patient ultimately attached to the handle three bands, which were fastened to the bed in various directions, and kept the mass of lead in place. This plan succeeded perfectly, when the weight was increased to about eleven pounds. By this means the subclavian artery was compressed during six or seven hours daily for about ten weeks, at the end of which time the size of the swelling had become reduced by nearly one-half, and the pulsations had almost ceased. The patient

¹ *Lancet*, November 15, 1873.

² *Guy’s Hospital Reports*, 3d S. vol. xviii. p. 61.

³ *Gazette Hebdomadaire*, No. 12, 1873.

was now dismissed from the hospital, but continued to apply the compression at home during several hours daily for ten months. Several years later he reported that the cure was complete; the place of the aneurism was occupied by a hard mass of the size of a nut, which did not impair the usefulness of the arm.

Generally, compression, applied in some of the ways mentioned above, should be faithfully tried before resorting to operative procedures with the knife, for the cure of traumatic aneurism of the axilla.

In cases where the "old operation" is practised, a drainage tube, deeply inserted, should be left in the wound. In such cases, also, antiseptic dressings are of great value, and, therefore, should be exclusively employed.

When the torn artery has been ligated above and below the rent in its tunics, by this method, should secondary hemorrhage ensue, the wound of operation must be promptly reopened, the bleeding point sought for and found, and tied anew with carbolized catgut.

Amputation near the shoulder, performed without delay, is the only expedient that can save the patient in cases where gangrene attacks the limb in consequence of an occlusion of the axillary artery resulting from rupture of its inner and middle coats, as happened in the cases reported by Professor A. Bérard, and Inspector-General Smart, R. N., which I have already presented. In such cases, the gangrene usually appears first in the fingers.

When the other arteries of similar magnitude that belong to the extremities, both lower and upper, are ruptured without external wound, the treatment should be conducted on the same general plan, for the underlying principles remain unchanged.

LACERATIONS OF THE MAIN ARTERIES OF THE EXTREMITIES CAUSED BY FRACTURE OF THE LONG BONES.—This accident has often been met with in the leg, and numerous examples of it have been reported. Dupuytren says that, from 1806 to 1825, he witnessed as many as seven cases of diffuse aneurism caused by fractures of the leg. He also says: "It may be that practitioners have overlooked this serious complication of fractures and gunshot wounds, because they have regarded it as beyond the ordinary resources of art to cure;" and he adds that, "in such cases, the universal recommendation has been to amputate." But this mode of treatment has been attended with a great fatality. For example, Pelletan amputated the thigh in three cases belonging to this category, and lost two of his patients by death.

J. L. Petit, in a fracture of the leg without external wound, saw the artery which passes between the two bones (doubtless the anterior tibial) laid open by the sharp edge of the broken tibia. The whole leg and foot became greatly swelled and ecchymosed; the part also became cold as well as discolored, and appeared gangrenous. He laid open the leg by an incision about six inches in length, extending above and below the fracture, and, discovering the open vessel, arrested the hemorrhage without displacing the bones. The case was then treated as an ordinary compound fracture, with success. This innovation was a great improvement. Boyer also recommended this plan of treatment, which consists essentially in cutting down upon the lacerated artery and tying its bleeding extremities.

Dupuytren, in 1809, tied the femoral artery at the middle of the thigh, in a woman, aged 62, for the cure of a diffuse aneurism resulting from a simple fracture involving both bones of the leg, at the junction of the middle and inferior thirds. The fracture was oblique; there was also great swelling and tension of the surrounding soft parts. On attempting the reduction, Dupuytren felt in the calf of the leg strong pulsation, distinct to the eye as well as to the touch, and synchronous with the heart's action; disappearing, too, on compressing the femoral artery, and returning on the withdrawal of the com-

pression. The vessel lacerated was, in all probability, the posterior tibial artery. The application of the ligature immediately suppressed all further pulsation in the tumor. On the sixth day the bulk of the tumor was already lessened by one-third. The woman perfectly recovered. Delpech, in 1815, acting on this precedent, ligated the femoral artery toward the upper part of the thigh, in the case of a postillion, aged 30, who had sustained a simple comminuted fracture of both bones of the leg near the centre, from the passage over it of the wheel of a loaded cart. The leg was discolored, and excessively distended from tumefaction. The tumefaction itself pulsated distinctly, especially at the calf; the pulsations were synchronous with those of the heart, and were controlled by pressure on the femoral artery. The patient made a good recovery. Dupuytren, in 1818, in a case of compound fracture, employed the same method that had been successfully employed in these two cases of simple fracture of the leg. An officer was shot through the upper part of his right leg by a pistol-ball. It passed from before backward and inward, traversing the interosseous space, and injuring both bones. Severe hemorrhage from both apertures immediately ensued; it was arrested by compresses. The leg swelled and became acutely painful; and afterward alarmingly benumbed. There was no external hemorrhage until the thirteenth day; but, meanwhile, blood was extravasated so as to form a diffuse aneurism which increased day by day in size, and exhibited pulsations which were synchronous with those of the heart, and immediately ceased on compressing the femoral artery. The hemorrhage which occurred on the thirteenth day was repeated at intervals, and greatly reduced the patient. At this time Dupuytren was called in, and found that the foot and leg were tumid, purple, cold, and benumbed; that there was a tense tumor at the upper part of the leg, which expanded and contracted with each beat of the heart; that this swelling was surmounted by two apertures, one in front, the other behind, made by the entrance and exit of the ball; and that these apertures had, for the last few hours, been closed by plugs of coagulated blood, which each pulsation threatened to dislodge. Fortified by his previous success, he tied the femoral artery at the middle of the thigh. Before tightening the ligature, he ascertained that pressure on the exposed artery arrested pulsation in the tumor. In three months the patient perfectly recovered.¹

Verneuil, in 1859, reported a case of diffuse aneurism from simple fracture of the leg, in which a new and much simpler plan of treatment was equally successful. The patient, being on horseback, struck his leg against a carriage-shaft, and broke it, but the fracture was masked during fifteen days by the swelling. The swollen region, however, was the seat of pulsations, synchronous with those of the femoral artery, and disappearing on compressing that vessel; the presence of a murmur or bruit was always doubtful. The *arteria dorsalis pedis* remained unaffected. Compression (intermittent) of the femoral artery upon the pubis was made by the patient himself; afterward, bags of shot were applied over the course of the femoral artery, and the cure became complete. Thus Verneuil avoided both amputation and ligation with perfect success. Azam has published a case of diffuse aneurism, with pulsation and murmur, that was caused by simple fracture of the leg at its inferior part, in which a cure was obtained by compressing the femoral artery at the pubis. The patient himself, by means of a watch-glass, compressed the artery from six to eight hours daily. Two months after the accident, the callus was solid and the cure complete.² Valette (de Lyon) has reported two analogous cases in which a cure was also obtained by compressing the femoral

¹ *Leçons Orales*, t. ii. pp. 521 *et seq.* Paris, 1839.

² *Nouveau Dictionnaire de Médecine et de Chirurgie pratiques*, t. xix. p. 550. Paris, 1874.

artery. In one of them, the fracture was complicated with an external wound of the leg, and with severe primary hemorrhage, which, however, was suppressed by pressure combined with the local use of the perchloride of iron. On the twentieth day the hemorrhage reappeared; the same means were again employed, but they failed to control it. Finally, Valette stopped the bleeding by digital compression of the femoral artery; and compression thus applied was continued during about ten days, by four journeymen locksmiths, comrades of the patient, who relieved each other every four hours. The wounded man completely recovered. In the other instance, compression of the femoral artery also succeeded, but the success was perhaps less striking, because the hemorrhage was less severe; nevertheless, the result was highly encouraging for the future employment of compression.¹

Symptoms of Arterial Laceration due to Fracture.—In cases of simple fracture, the occurrence of this accident is denoted by the following signs: tumefaction tense in character, discolored by subcutaneous ecchymosis, increasing rapidly, and pulsating synchronously with the heart; the pulsations themselves ceasing on compressing the main artery on the cardiac side of the swelling, and returning on withdrawing the compression; and the tenseness of the swelling growing markedly less under compression of the main artery, to return again when the compression is discontinued. The peculiar thrills and murmurs which are found in spontaneous aneurisms may also be present in diffuse aneurisms from fracture. But the thrill is often, and the murmur sometimes, absent in such cases. For instance, in Verneuil's case, related above, the presence of a murmur was always dubious. When the arterial wound is very small or very oblique, neither distinct pulsations, nor aneurismal thrills, nor aneurismal bruits are to be found, but only an impulsion, synchronous with the contraction of the heart, is imparted to or discernible by the hand. In an example presented by Dupuytren, a sort of tremulous movement, increasing and diminishing alternately, was perceptible in the swelling, but no distinct pulsation. This tremulous movement, however, ceased when the popliteal artery was compressed; and, at the same time, the swelling was observed to become less tense, and to diminish a little in volume. The tremulous movement, and the tension, and the volume of the swelling, too, were restored when the pressure was removed from the artery. The diagnosis was, therefore, not doubtful. Moreover, in certain patients an aneurismal bruit has been recognized in the swelling, when pulsation, or impulsion, or tremulous movements have been wholly wanting in it. The symptoms of diffuse aneurism may not appear until several days after the fracture, because the artery remains unopened until that time. In one of Pelletan's cases, they did not appear until the seventy-fifth day. In such cases the artery is, for the most part, penetrated by ulceration from pressure exerted by the fragments.

When the fracture is compound and the hemorrhage is external, the blood is bright red, but it rarely issues in jets. As syncope approaches, the bleeding can generally be stopped by local applications, but after some days it returns as strongly as ever; it may do so again and again, and, if they be not properly treated, these successive hemorrhages must end by carrying off the patient. One of Valette's cases, related above, illustrates this point; so also does one of Dupuytren's examples.

Fr. Poncet² presents in a tabular form twenty-one cases of diffuse aneurism resulting from fracture of the leg, that occurred in the practice of Ribes, Desault, Dupuytren, Delpech, Mirault, Lisfranc, Guthrie, Travers, and others,

¹ Ibid., t. xix. p. 585. Paris, 1874.

² Nouveau Dictionnaire de Médecine et de Chirurgie pratiques, t. xv. p. 497. Paris, 1872.

in which either ligation or compression was resorted to. No mention, however, is made therein of those instances of this accident, although they are quite numerous, which have been treated by amputation of the thigh, or have been allowed to run their course without surgical interference, and which have terminated fatally by hemorrhage or by gangrene. The following is a brief summary of the tabulated cases:¹—

	CURES.	DEATHS.
Ligature of the femoral artery has furnished	5	1
Ligature of the tibial above the tumor	3	2
Ligature of the peroneal	2	—
Compression applied in the wound	—	2
Compression applied to the main artery above	3	—
Add the cases of Verneuil and Valette	3	—
	<hr/> 16	<hr/> 5

To these, Azam's case, related above, in which a cure was obtained by compressing the femoral artery at the pubis, is to be added, which gives in all seven examples of this formidable lesion that have been cured by indirect compression, without any accident, and without any failure. Ligation of the femoral artery at or above the middle of the thigh has furnished five recoveries, and one death. The most dangerous plans of treatment are, beyond doubt, compression applied in the wound, and ligation of the injured artery immediately above the tumor; and, therefore, these should generally be considered as inapplicable to, and not permissible for, this lesion.

Appreciation of Methods.—There are four distinct surgical procedures which may at times be required in treating the lacerations of arteries which are caused by fractures of the leg. (1) Indirect compression, that is, compression of the parent vessel, or arterial trunk, on the cardiac side of the laceration, at some considerable distance from it. (2) Ligation of the lacerated artery itself, on each side of the laceration. (3) Ligation of the superficial femoral artery, at or above the middle of the thigh. (4) Amputation.

(1) *Compression* of the femoral artery at the pubis, from its innocuousness, and the remarkable success which has attended its use, is far preferable to every other plan of treatment; and the surgeon should always make faithful trial of it, when practicable, before proceeding to operate with the knife. It is always advisable to make digital compression in such cases, if possible; but this plan of treatment requires the co-operation of at least several intelligent assistants; these are not always at hand, and in the country especially the surgeon may oftentimes be unable to find them. He should then, if he can, resort to the use of instruments for compressing the femoral artery, such as I have already described on pages 521 *et seq.* But, after all, there will be cases in which, either from want of the means to make compression, or from failure of the compression itself, recourse must be had to other procedures.

(2) The "*old operation*," that is, the ligation of the torn artery itself in the wound, above and below the rent in its tunic, although J. L. Petit performed it with success, is not admissible in cases of simple fracture, because it would convert them into compound fractures. There is no pretext under which a surgeon can justify himself in voluntarily converting a subcutaneous into an open fracture. But in cases where the fracture is already compound, and the hemorrhage is external, when compression of the femoral artery at the pubis is impracticable or ineffectual, it is often, perhaps generally, advisable to lay open the swelling, by enlarging the original wound, if necessary, in order to

¹ There are also a good many instances of this accident on record in which the "*old operation*" was performed, or recovery spontaneously occurred, that are not mentioned or embraced in Poncet's table.

find the lacerated artery and secure it with ligatures of carbolized catgut applied on each side of the aperture in its walls. The external wound should then be closed and treated antiseptically.

(3) *Ligation* of the superficial femoral artery, at or above the middle of the thigh, as originally recommended and practised by Dupuytren, is the operation which must be performed in cases of diffuse aneurism resulting from fractures of the leg that are simple or unattended with external wounds, whenever compression of the femoral artery is impracticable or proves ineffectual.

(4) *Amputation* at the knee should be performed, without delay, as soon as gangrene appears in the toes or foot belonging to a limb where this accident has occurred; and there is but one circumstance besides gangrene which makes this operation admissible for the lesion in question, and that circumstance is the failure of all other plans of treatment.

The surgeon should, generally, when this accident has occurred, be in no great hurry to operate with the knife, unless there is external hemorrhage not amenable to compression, or unless gangrene makes its appearance; and then he cannot perform the operation of ligation on the one hand, or amputation on the other, too speedily.

Concerning the application of compression to the femoral artery for this lesion, the surgeon should never, in an excess of zeal or anxiety, ignore the fact that it need not suspend the circulation entirely, need not even act continuously, in order to effect a cure. In several of the cases presented above, where the success was most striking, the compression was intermittingly applied, and in two instances it was made by the patients themselves. Thus the surgeon may, without risk, substitute for the intolerable torture of the old modes of compression, a treatment which, in ordinary cases, is harmless, and which, in a few, is absolutely painless.

But the occurrence of diffuse traumatic aneurism in consequence of fracture is not restricted to the leg, although it is met with in that region much oftener than elsewhere. Fractures of the thigh, likewise, are not unfrequently complicated by lacerations of large arteries, and by the appearance of sanguineous tumefactions communicating with the canals of the torn vessels, which, in default of a more appropriate name, are called diffuse traumatic aneurisms. Gürtl¹ presents a long statistical table, containing twenty-five examples of this accident that occurred in the thigh, leg, and arm; *four* of them were observed in the thigh, *twenty* in the leg, and *one* in the arm. The four thigh cases were reported by Bransby Cooper, by Lyon of Glasgow, by Trugen of Posen, and by Guthrie. Three of these patients died and only one recovered. The excessive mortality sufficiently attests the gravity of the lesion. The following case occurred at the Middlesex Hospital, under the care of Mr. Moore:—

In a man, aged 35, having simple fracture of the femur, there was an extensive swelling of the thigh, together with an arterial bruit in some vessel—not the femoral artery—which could be felt below the seat of injury.² The symptoms of an arterial wound in this case, viz., the bruit and swelling, disappeared under the influence of the absolute rest of limb and general quietude of body which the fracture necessitated, that is, without any special treatment, and the fracture itself united in three months.

It is probable that in the examples of this accident met with in the thigh, the branches of the femoral artery are the seat of the lesion much oftener than the parent vessel.

¹ Handbuch der Lehre von den Knochenbrüchen, Bd. i. S. 526–537.

² Holmes's System of Surgery, second ed., vol. iii. pp. 519, 520.

The arm case contained in Gürlt's statistical table was reported by Perussault, and the patient recovered. There was crushing (*zerschmetterung*) of the external condyle of the right humerus, of the olecranon, of the radius, and of the ulna. The following arm case was under Mr. Moore's care at the Middlesex Hospital, and is of special value in this connection, because it illustrates the subject much better than many words of abstract description:—

A woman, aged 42, injured her right arm by falling down stairs at night, and presented herself next day. The whole hand and forearm, and part of the upper arm, were tensely swollen and covered with bullæ of various, but principally of small size. Serum mixed with blood filled the bullæ. Fracture of the olecranon was easily made out, but no other osseous lesion could be detected. On the following day the swelling was larger, and the vesications more extensive. There was an aneurismal pulsation in front of the elbow, strong and expanding, but deeply seated. The impulse extended half-way up the inner side of the arm, and more than half-way down the whole palmar surface of the forearm. A distinct bruit was heard with the stethoscope in front of the elbow. The two arteries at the wrist beat so forward and so forcibly, and appeared so much larger than those of the other side, as to give the idea that they had been raised up by extravasated blood, and that the pulsation was communicated to the distended sheaths of the vessels. The skin on the hand was dusky from congestion; and when the color was expelled by pressure, it returned very slowly, showing the embarrassed condition of the circulation. The limb was everywhere warm, however, and there was no sign of impending gangrene. At the consultations various opinions were expressed as to the appropriate treatment; but it was agreed that some large artery, possibly the brachial, was wounded. It was ultimately decided to watch the case. In the evening, the swelling was found not to have increased, and the hand was certainly less tense. A rounded swelling was found near the armpit, in the neighborhood of the brachial artery, which appeared to be the end of the clot of extravasated blood. On the following day (the third from the accident) pulsation had ceased in all other parts, and was perceptible only in front of the elbow, over a space about as large as a half-crown, and not strong. Next day the aneurismal pulsation disappeared, and the swelling afterward gradually subsided. When the subsidence was sufficient, fracture of the lower end of the humerus was detected. The case did well.¹ This case shows that lacerations of healthy arteries, when uncomplicated with external wounds, sometimes show a remarkably strong tendency to recovery.

Mr. De Morgan, in a clinical lecture at the Middlesex Hospital, also says: "We have had, within the last few years, two or three cases of simple fracture where there was a large and rapid effusion of blood beneath the skin, and marked aneurismal pulsation; in which, however, arrest of the hemorrhage ensued spontaneously, and complete absorption took place, although it was clear that a large artery had been torn through."²

Diffuse traumatic aneurisms, resulting from fractures, when they occur in the thigh or arm, should be treated on exactly the same principles as when they occur in the leg, a thorough discussion of which accidents has just been presented. I must, however, add that examples of this accident occurring in the leg, too, sometimes recover without any special treatment of the arterial lesion. Such a case was under the care of Mr. Mitchell Henry, at the Middlesex Hospital. The posterior tibial artery was wounded, in a boy who had simple fracture of the leg. The diagnosis rested on the absence of pulsation in that artery and the presence of bruit in the swelling, together with a peculiar restlessness of the limb. The fracture healed slowly (in about two months), and these symptoms gradually subsided, but the pulse did not return in the affected artery.³ In such cases it is sometimes said that the arterial wound heals spontaneously; it must not be forgotten, however, that but few

¹ *Ibid.*, pp. 519, 520.

² *British Medical Journal*, January 6, 1872.

³ Holmes, *System of Surgery*, 2d ed. vol. iii. pp. 519, 520.

things which the surgeon may do can promote the closure of the torn artery and the absorption of the extravasated blood, more effectually than the fixed position, absolute quietude, and equable support of the injured part, with general quietude of the whole body, which the fracture and its dressings enforce. Compression, digital or instrumental, of the main artery, should always be thoroughly tried in the thigh and arm, as well as in the cases of this accident occurring in the leg, before resorting to the "old operation," or to ligation of the main artery on Hunter's plan.

There is good ground for hope that almost all arteries of the extremities, both lower and upper, when wounded in cases of simple fracture, will heal when the fixed position and quietude, just mentioned, are supplemented by adequate compression of the parent vessel. The appearance of gangrene in such cases necessitates the immediate performance of amputation.

But traumatic aneurisms resulting from fractures are not confined to the regions of the leg, thigh, and arm; they are also found in any part of the body where an artery lies sufficiently near the bone to be pierced or torn by its broken fragments. Mr. Busk and Mr. Curling have each placed on record a case in which a traumatic aneurism formed upon the ophthalmic artery in consequence of fracture of the base of the skull. In both cases the carotid artery was tied, and in both with complete success.¹

GUNSHOT WOUNDS OF ARTERIES.

The large arteries of the extremities are, to a considerable extent, protected from gunshot perforations, by the strength of the fibrous sheaths which invest them, by the toughness and extensibility of their own tunics, and by the readiness with which they can slip aside from the track of a gunshot missile, owing to the fact that they are elastic tubes, and that their contents are liquid. By these means, doubtless, the large bloodvessels often escape lacerations from bullets; and in this way we can account for the fact that such arteries as the femoral, the carotid, and the brachial are found to be practically uninjured, although lying exactly in what appears to be the track of the missile. The late civil war furnished numerous examples. "A number of drawings at the Army Medical Museum, exhibiting the course of balls directly in the track of the great bloodvessels of the neck or of the limbs, illustrate the fact, so well known to military surgeons, of the great resiliency of the large arteries."² The surgical historian of the British Army in the Crimean War justly observes:—

"The amount of this resiliency of the large arteries of a limb is much greater than is usually supposed. Thus, in a soldier of the 56th Regiment, a fragment of shell passed through the ham, between the artery and the bone, without injuring either, although it was much too large to have done so without displacing the vessel. The man afterwards died of diarrhoea. In the 9th Regiment a similar case occurred, but in it a portion of the bone was scooped out by the missile, and the man recovered. In the 47th Regiment, a large piece of shell passed through the upper third of the thigh, between the artery and the bone, but injured neither, and recovery took place."³

Notwithstanding this wonderful resiliency of the arteries of the neck and extremities, which oftentimes enables them to escape all serious injury even when they appear to lie exactly in the track of wounds made by gunshot missiles, it not unfrequently happens that they sustain solutions of continuity

¹ Medico-Chirurgical Transactions, vols. xxii, xxxvii.

² Circular No. 6, S. G. O., p. 39.

³ Surgical History of the Crimean War, vol. ii. p. 340.

from the impact of such missiles. Experience has shown that these arteries may be wounded in such a way as to have their calibres directly opened by musket, rifle, carbine, and pistol-balls, by case-shot, and by fragments of shells. It seems, however, to be necessary for the accomplishment of such a result, that the missile should be moving with great velocity at the moment when it strikes the artery. Hence it happens that bullets are much less likely to penetrate the arteries after they have passed through the compact structure of the long bones of the extremities, than they are before making such a passage through osseous tissue. If the velocity of the missile has been considerably lessened ere it impinges against the artery, it may only bruise its tunics;¹ but, in so doing, it may cause as much damage to the patient as it would have done by opening its calibre.

The solutions of continuity or breaches, produced in the walls of blood-vessels by gunshot missiles, are essentially contused and lacerated in their nature, and usually present some of the features which belong to each of those classes of injury. They can, therefore, be most conveniently considered in this place, that is, immediately after the contused and lacerated wounds of arteries have been discussed.

The breaches in the walls of bloodvessels which gunshot projectiles occasion may be separated into two important groups:—

1st. Partial or incomplete division of the vessel, considered as a tube for the transmission of blood.

2d. Complete division of the same.

We find, on studying attentively the details of this subject, that each of these groups presents peculiarities in respect to phenomena and consequences, of so much importance in both a scientific and practical point of view as to demand for each a separate consideration.

Examples of gunshot injury in which the wound of an artery constitutes the sole or even the principal primary lesion are not of frequent occurrence in surgical practice, and are not often met with by surgeons even on battle-fields, although arterial wounds very often present themselves as complications, it is said, of gunshot fractures and other important injuries. On this point the late Dr. Otis, the distinguished historiographer of our civil war, remarks:—

“The number of cases reported under this head is extremely small. In the campaign of the Army of the Potomac, from the Rapidan to the James, in May, June, and July, 1864, of a total of 36,508 gunshot wounds, only twenty-seven belonged to this category. The cases of compound fracture complicated with injuries of the large vessels, the cases in which limbs are carried away by solid shot or shell, and the cases in which all the tissues of the limb are disorganized by contusion from a large projectile, and the vitality of the arteries is destroyed, are all returned under other heads. Those only are included in which the canal of a large vessel is primarily opened, and in which this is the principal accident. Such cases are to be sought for among the dead on the battle-field, rather than in the field hospitals.”²

Again, in almost all the cases where an artery of considerable magnitude has been opened by a gunshot missile, which are brought to the surgeon for treatment on the field of battle, the injured vessel is found to be situated in the extremities, in the neck, or in the head, but most frequently in the extremities. Gunshot wounds of the great arteries of the abdomen and the thorax fail to come under the notice of military surgeons, not because these vessels escape all injury, but because, whenever they are opened, death usually very speedily ensues. I am fully convinced from personal observation, that these vessels are frequently wounded in battle; that such injury is, for the

¹ See Contused Wounds of Arteries.

² Circular No. 6, S. G. O., pp. 38, 39.

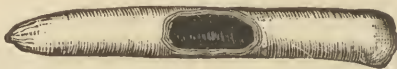
most part, very quickly followed by death from hemorrhage; and that this form of gunshot lesion should be ranked as one of the principal causes of sudden death in warfare. The subjects of this form of gunshot injury almost always perish from hemorrhage before they can be taken up from the field, and hence they are generally reported on the company-rolls as killed.

PARTIAL OR INCOMPLETE DIVISION OF ARTERIES BY GUNSHOT MISSILES.—This lesion presents itself in two principal forms. In one of them a side of the arterial tube has been carried away; in the other, the vessel has been perforated through and through by the missile. The former occurs much oftener than the latter. The former is met with in vessels presenting much variety in respect to size; the latter only in large ones. But the consequences of the arterial wound are quite similar in both instances.

The following abstract, and the woodcut which accompanies it (Fig. 427), afford a most excellent example and illustration of the partial division of a large artery by a cylindro-conoidal bullet:—

A soldier, aged 19,¹ was accidentally wounded, January 11, 1866. The missile, a conoidal musket-ball, entered his right side, just below the cartilages of the false ribs, passed upward, and fractured the eighth rib; it then emerged from the chest, and, entering the axilla, traversed the arm, and passed out at the top of the shoulder, without

Fig. 427.



Gunshot wound of the right axillary artery; pieces of cloth, driven in by the ball, moderated the bleeding. (Spec. 2674, Sect. I., A. M. M.)

injuring the humerus. He was taken to the post-hospital, in a state of syncope, unable to speak and almost pulseless. His extremities were cold, and he was said to have lost a bucketful of blood. Powerful stimulants were immediately administered. The hemorrhage did not return until the 20th, when he lost about fifteen ounces. It was stopped by compression. It again recurred on the 21st, and he lost about twenty ounces. On the 22d, although the prostration from loss of blood was extreme, it was deemed expedient to tie the axillary artery, which was accordingly done with a single ligature; but he survived the operation only a few minutes. During the operation several fragments of cloth were extracted, and also two pieces of the axillary artery. On the extraction of the cloth, hemorrhage, *per saltum*, commenced, but it was easily controlled by compressing the subclavian above the clavicle, with a door-key. *Necroscopy*—A large semicircular piece, embracing about half the calibre of the vessel, was cleanly cut out by the ball from the side of the axillary artery, about one inch below its origin; brachial plexus uninjured. The fragments of cloth and flesh which were extracted during the operation had doubtless been driven into the artery, and their dislodgment by accident or by suppuration brought on the secondary bleeding. Such a wound of the axillary artery usually causes death from primary hemorrhage in about five minutes. The accompanying woodcut (Fig. 427) represents the specimen, which is preserved in the Army Medical Museum.

The wound was inflicted, whilst the man was lying in his tent, by a comrade who was handling a loaded musket. The missile was therefore moving with great velocity, and it cut cleanly out a large semicircular piece from the side of the axillary artery, embracing about one-half its calibre. Generally, when large arteries are laid open by gunshot missiles, the wounds are inflicted at short range by small-arm projectiles, the missiles moving with great velocity at the moment of impact; especially when such arteries as the

¹ Med. and Surg. History of the War of the Rebellion, First Surg. Vol., p. 553.

femoral, the carotids, the axillary, and the brachial, are involved. But wounds inflicted at long range by the same class of projectiles, may be attended with contusion of these arteries; or, from their resiliency, they may escape all appreciable injury.

An important fact connected with this case, wherein the main artery of the upper extremity was cut half-way across by a cylindro-conoidal ball, only one inch below where it is called subclavian, is that the bits of cloth carried into the wound by the ball, and the occurrence of syncope, stopped the primary hemorrhage. Another important fact is, that the bleeding was restrained for nine days, that is, until the bits of cloth, pieces of flesh, and occluding clots had become loosened and detached by suppuration.

The following abstract and woodcut (Fig. 428) present us with another instance and illustration of the incomplete division of a large artery by a cylindro-conoidal missile:—

A corporal, aged 22,¹ was wounded May 3, 1863, by a conoidal musket-ball, which entered the nose and escaped near the right ear, having shattered the right superior maxilla in its course. Slight hemorrhage began on the 9th, but it yielded to compression. It recurred, however, several times with great profuseness; the patient became frantic with alarm, and prevented all attempts at compression, etc.; and died, rather suddenly, from hemorrhage, on the 11th—eight days after the casualty. The specimen is represented in the accompanying woodcut (Fig. 428), which shows the terminal portion of the common carotid, the first portion of the internal carotid, and the external carotid from its origin up to and beyond the site of the gunshot lesion of its walls.

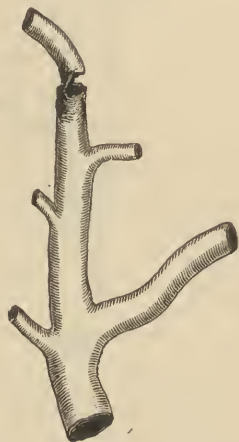
In this case the primary hemorrhage, which doubtless was severe, ceased on the approach of syncope; for the bruised and lacerated tissues surrounding the track of the ball afforded a good lodgment for a coagulum to plug the wound, and thus stop the outflow of blood. The hemorrhage was restrained until the sixth day, when the bruised and lacerated tissues, or the slough, surrounding the hole made by the ball, began to get loose, preparatory to their discharge by ulceration.

The following abstract and woodcut (Fig. 429) also illustrate in a useful manner the partial division of a large artery by a gunshot projectile:—

A soldier,² aged 25, on July 3, 1863, received a gunshot wound of the neck and face. On the 9th, secondary hemorrhage from the external carotid artery, to the extent of twelve ounces, occurred. On the 10th, the common carotid was ligated, three-quarters of an inch below the bifurcation. The hemorrhage did not return; but, on the 13th, the patient died. The specimen is represented in the annexed woodcut, which shows well the lesion of the external carotid, the ligature in position on the terminal portion of the common carotid, etc. (Fig. 429.)

As in the last case, so in this, the hemorrhage was restrained by the coagulum that plugged the wound until the sixth day, when the slough began to separate. But the secondary bleeding which then occurred was arrested by tying the common carotid artery, and did not return. The patient, however, died three days after the operation, probably from anæmic exhaustion caused

Fig. 428.

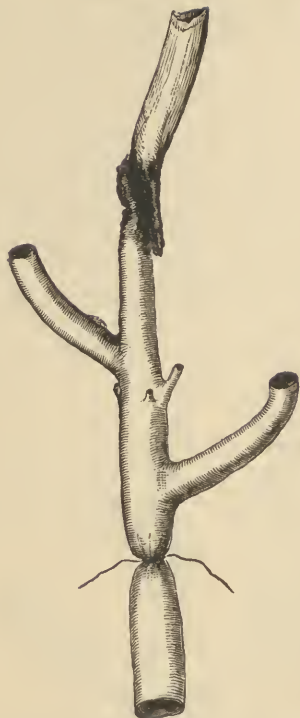


Shot-wound of the external carotid, near the origin of the internal maxillary artery. (Spec. 2222, Sect. I., A. M. M.)

¹ Med. and Surg. History of the War of the Rebellion, First Surg. Vol., p. 396; also, Catalogue of Army Medical Museum, p. 455.

² Med. and Surg. History of the War of the Rebellion, First Surg. Vol., p. 420.

Fig. 429.



Shot-wound of the external carotid artery, and ligation of common carotid. (Spec. 3969, Sect. I., A. M. M.)

by the losses of blood which had occurred before the operation.

An example of this form of injury that occurred in the lower extremity, will be useful: Colonel Roderick Matheson, commanding the 32d New York Volunteers, was wounded in the battle of Crampton Gap, Maryland, September 14, 1862, the ball passing through his right leg, and fracturing the fibula in its course. Cold water dressings were applied. Six days after the casualty, a slight discharge of dark-colored blood occurred, and two days afterwards was repeated; the whole amount of both hemorrhages did not exceed four fluidounces. No further bleeding appeared until the seventeenth day, when about a pint escaped, not enough, however, to cause syncope. Next day, under chloroform, the coagulum was removed, when considerable hemorrhage followed, coming, as was soon ascertained, from the posterior tibial artery. It was then decided to enlarge the wound and tie the artery in it, which was accordingly done. On exposing the artery, one side of it was found to have been carried away, to the extent of nearly one inch; a ligature was placed around it, both above and below the aperture, a few pieces of bone were removed from the fractured fibula, and the patient was placed in bed. Symptoms of great prostration being present, every possible effort was made to rally him, but without avail. He lived but a few hours after the operation.¹ For two or

three months before the casualty the patient had suffered from army-diarrhœa, in consequence of which he was much enfeebled; too much, in fact, to survive the loss of blood and the shock of the operation.

The partial division of large arteries by gunshot missiles, as these cases show, is very dangerous to life. The aperture in the tunics of the injured vessel gapes widely open from contraction of the arterial fibres, but lessening of the vessel's calibre at the place of injury from contraction of the arterial fibres does not occur; retraction of the injured portion into the arterial sheath cannot take place; an internal coagulum, or a clot within the mouth of the wounded vessel, cannot be formed; and the external coagulum adheres so loosely to the mouth of the wounded vessel that sooner or later it becomes displaced, and then either a traumatic aneurism will form, or a hemorrhage will burst forth externally, and the patient will lose his life unless surgical aid is seasonably obtained.

The *perforation* of arteries from side to side, which constitutes the only remaining form of the partial division of arteries that may be caused by gunshot projectiles, is not often met with in the extremities; nevertheless, Professor Alfred C. Post has reported a good example:—

Henry Schatt, aged 30, wounded March 25, 1865, was admitted into Mount Pleasant Hospital April 2, with a gunshot wound of the left thigh. A conoidal ball had passed through the popliteal space from without inward, injuring the popliteal artery. On

¹ American Medical Times, Feb. 28, 1863, p. 101.

the day of his admission, the thigh was amputated by the circular method, under ether and chloroform (mixed). Very little blood was lost. There was good reaction. The toes of the amputated limb were bluish; the foot was cold, and covered with bluish and purple spots. The entire leg was greatly swollen; the superficial veins engorged. Small veins on the inner surface of the thigh were somewhat discolored; the integument presented a yellowish color. The pulse of the patient, at the time of the operation, was small, sharp, and frequent. The face was pale, and the tongue coated. The popliteal artery was found to have been *perforated by the ball*, and to be nearly surrounded by a large traumatic aneurism. The tissues of the posterior part of the leg were infiltrated with blood down to its middle third. The popliteal vein was not injured. There was a slight fracture of the inner part of the head of the tibia. After the operation the edges of the wound were approximated with strips of adhesive plaster, and cold-water dressings were applied. On May 31 the patient was recovering, and it is believed that he ultimately got entirely well.¹

The symptoms in this case denoted that gangrene of the foot and leg was about to occur, and the performance of amputation was therefore indispensable. Moreover, gunshot wounds involving the popliteal artery are exceedingly apt to be followed by gangrene of the foot and leg; and the cause of this liability will be shown in the sequel.

The following, likewise, is a good example of the gunshot perforation of a large artery:—

The Army Medical Museum² possesses an example of perforation, from before backward, of the right primitive iliac artery, by a pistol-ball. (See Fig. 311, *supra*, page 200.) The patient lived twelve minutes after the reception of the wound, so that, had a competent surgeon been at hand, and had the abdominal aorta and left primitive iliac artery been firmly compressed against the spine immediately after the casualty, so as to stay the hemorrhage for the time being, it would have been possible to tie the vessel above and below the wound with success.

When a large artery is notched or perforated by a gunshot missile, the single orifice that is caused by the notching, or the double orifice that is caused by the perforation of its walls, as the case may be, never heals spontaneously, for reasons which have just been presented; and if the track of the missile through the parts that surround the artery is in such a condition as to allow unrestrained communication between the orifice in the vessel and the exterior of the body, or the interior of one of its great cavities, such as the cavity of the abdomen or that of the thorax, the patient soon perishes from hemorrhage, unless efficient surgical aid is very promptly afforded. In cases where the arterial orifice happens to be primarily closed by bits of clothing, or by the torn and disintegrated tissues themselves, or by blood-clots, the hemorrhage may thus be restrained until the separation of the disintegrated tissues as a slough begins, when the hemorrhage that has been suppressed for some days will reappear, and the patient will perish from the loss of blood, unless surgical assistance be near at hand.

But when from closure of the external wound by pressure, or from closure of the track of the ball by the sliding past each other of muscular planes and fasciæ, which sometimes occurs on altering the position of the injured part, the external hemorrhage ceases, but, at the same time, the internal does not cease, the blood continues to issue from the aperture in the wounded artery with each contraction of the heart, and, finding no vent, accumulates in the surrounding connective tissue, thus forming a diffuse traumatic aneurism which may prove fatal by bursting and bleeding, or by causing gangrene, as occurred in Prof. Post's case above quoted.

¹ U. S. Sanitary Commission Surgical Memoirs, pp. 47, 48. New York, 1870.

² Med. and Surg. Hist. of the War of the Rebellion, Second Surg. Vol., pp. 323, 324.

Treatment of Partially-divided Arteries.—Arteries when opened or partly divided by gunshot missiles must always be secured in the wound, if possible, by two ligatures, one being placed above and the other below the aperture in the arterial tunics. The artery should also be completely divided between the two ligatures. In the following case this operation was performed on the femoral artery, with a most excellent result:—

Corporal H. C., Co. I., 114th Colored Troops, aged 29, was accidentally wounded at Fort McIntosh, Texas, December 18, 1866, by a conoidal pistol-ball, which entered two inches below Poupart's ligament, and, passing inward, downward, and backward, emerged from the inner part of the thigh three inches below the level of the point where it entered, injuring the superficial femoral artery half an inch below the profunda. When brought to the hospital, he was very faint from excessive loss of blood. Four hours after the accident the wound of entrance was enlarged by incision, the patient being under ether; a tourniquet was applied, and the femoral artery ligated above and below the seat of injury. The wound of exit was then enlarged to favor drainage. On Dec. 31 the patient was doing well. On Feb. 28, 1867, he returned to duty, cured.¹

Arterial wounds attended with brisk hemorrhage must always have digital compression instantaneously applied either in the wound itself, or upon the proximal portion of the wounded artery, or upon the parent trunk, by methods already described, in such a way as to suppress the bleeding until ligatures can be placed around the injured artery, as just directed. In cases where large arteries like the common carotid, the common femoral, the axillary, etc., are laid freely open by gunshot missiles, compression of the open mouth of the injured vessel, directly and instantaneously effected, with one or more fingers inserted into the wound and kept there until a surgeon can be brought and ligatures applied, affords the only means of saving the patient. In such cases, a delay of but one or two minutes in applying the pressure may be attended with the loss of so much blood as to prove fatal, either immediately by syncope, or after some days by anæmic exhaustion. When the operation of tying the injured artery in the wound with two threads is not practicable, the injured artery itself, or its parent trunk, must be secured by ligating it with carbolized catgut, on the cardiac side of the wound, but as near to it as possible. Under such circumstances, Anel's plan of operating should generally be preferred to that of Hunter; for instance, in a case where the tongue is wounded, the lingual artery should be tied instead of the carotid; or, if the wound involve the external carotid, that artery should be ligated instead of the common carotid, etc. Anæmic exhaustion resulting from hemorrhage should, in uncomplicated cases, be treated by transfusion. In those cases of gunshot arterial lesion where, after the hemorrhage has ceased externally, it continues internally in the shape of an extravasation into the connective tissue, that is, in those cases where a diffuse traumatic aneurism forms, the surgical treatment should, in general, be precisely the same as if the external bleeding had continued; for, in both instances, the lesion to be treated is the same, namely, the arterial wound. When gangrene ensues, our sole expedient is amputation; and this operation should be performed without delay, that is, before the system at large becomes septicæmic in consequence of the passage into it of putrid blood and serum from the gangrenous part.

These three operative procedures, namely, ligation in the wound, ligation on Anel's and Hunter's plan, and amputation, should never be held in abeyance, as expedients of last resort, while other things are being tried; but, on

¹ Circular No. 3, S. G. O., Washington, August 17, 1871.

the contrary, each of them should be promptly performed by the surgeon whenever it is indicated as the best means at his command for saving life.

The treatment of gunshot wounds of arteries, when complicated with gunshot fractures, will be considered hereafter.

Concerning the employment of *styptics*, as, for instance, the persulphate and the perchloride of iron, etc., as hæmostatic agents in hemorrhages from gunshot wounds of arteries, some mention should here be made. In the first place, in the instances where large arteries are opened by musket-balls, etc., they are entirely inadequate to meet the requirements of the case. When the hemorrhage proceeds from small arteries, such *styptics*, even when aided by local compression and cold, are often worse than useless. Thirteen fatal cases of bleeding from the minor branches of arteries in the upper extremity are reported in the Medical and Surgical History of the late Civil War.¹ In a number of these cases the application of *styptics* contributed much to the fatal issue.

To imperfect or inadequate ligation several of these deaths must also be directly charged. For example, four cases of ligation of the radial artery in gunshot wounds unattended by fracture terminated fatally:—"It is noticeable that in these four fatal cases proximal ligatures only were applied."² All the cases in which the radial artery was secured with distal as well as with proximal ligatures ended in recovery. Of five patients in whom the ulnar artery was tied above and below the lesion, for hemorrhage in gunshot wounds, all recovered but one, and he died of pyæmia. In three instances where the ulnar artery was tied on the proximal side only of the lesion, "two of the three patients died, one having undergone consecutive amputation; the third recovered, after consecutive ligation of the brachial."³ The surgeon should never forget that, "when the injury is inflicted on an artery near the extremity of a limb, it is *indispensable* to employ the double ligature, on account of the multiplied communications by anastomosing branches." (Dupuytren.)

Thus experience shows that hemorrhage from wounded arteries should not be treated by applying *styptics* when it is practicable to ligate them; and that a distal as well as a proximal ligature should be placed around the wounded vessel.

COMPLETE DIVISION OF ARTERIES BY GUNSHOT MISSILES.—Small arteries are severed in almost every case of gunshot wound; yet this accident but seldom causes troublesome hemorrhage, or any other bad consequence. The bleeding from these small vessels, when they have been completely divided by gunshot projectiles, spontaneously ceases in a short time, as a rule, and does not recur.

Large arteries, too, have sometimes been found severed in the wounds made by small-arms, but not often; much less often than they are found notched or perforated, that is, incompletely divided in such wounds. For the severance of arterial trunks, and of large arteries in general, by rifle or pistol balls, it is especially needful that the missile should be moving with very great velocity at the moment of impact. The same missile proceeding in exactly the same track, but with less velocity, might only notch the artery; moving with still less celerity, it might only bruise the arterial tunics; and, if moving more slowly still, it might leave no trace of arterial injury. The late Dr. Otis justly calls attention to this point. He remarks:⁴ "The reader will observe here, as elsewhere, the very large proportion of gunshot wounds of arteries in accidents, assassinations, and suicides, in comparison with those

¹ Second Surg. Vol., p. 460.

² *Ibid.*, pp. 452, 453.

³ *Ibid.*, p. 452.

⁴ Circular No. 3, S. G. O., p. 55.

received in battle. In other words, that the great arterial trunks are often divided at very close range by the small projectiles, but very rarely at long range." The velocity of these projectiles is, of course, very much greater at short, than it is at long range. I shall illustrate the principal facts pertaining to the division of arteries by small-arm missiles, by presenting a number of well-authenticated examples. In the first three cases the carotid artery was involved:—

Private James B. Morrissey, Co. B. 34th United States Infantry, was shot through the neck, at Grenada, Mississippi, March 28, 1868. The missile entered two and one-half inches below the lobe of the *left* ear, and emerged on the *right* side of the nape one inch and a half from the spinous processes. The carotid artery was severed, and death was almost instantaneous.¹

Private George Robinson, Co. D, 40th U. S. Infantry, was shot on August 26, 1868, by the officer of the guard, for mutinous conduct at the United States Army post, Goldsborough, N. C., with a Colt's navy revolver, in the neck, the ball severing the carotid artery. Death from hemorrhage resulted almost immediately, September 13, 1868.²

Major John A. Thompson, 7th U. S. Cavalry, was wounded by a pistol-ball while engaged in suppressing an affray between a party of soldiers and desperadoes, near Fort Mason, Texas, on November 14, 1867. The missile struck the right malar bone, and emerged below the left ear, severing the left carotid artery. He was taken to the post hospital, and died the next day, from hemorrhage.³

In the following instance the subclavian artery was divided:—

Private James Smith, Co. I, 38th U. S. Infantry, was shot, by the accidental discharge of a Springfield musket (calibre 50), in the hands of a comrade, while standing in the door of the company quarters. The ball entered the right shoulder from behind, and, passing through the scapula, divided the subclavian vessels and fractured the clavicle. Death was almost immediate.⁴

In the next three examples the external iliac artery was severed:—

Private John Gerhardt, Co. K, 2d U. S. Infantry, aged 22, received, on January 9, 1869, accidentally, a gunshot wound of the groin. He was immediately admitted to the regimental hospital, and died one hour afterward of hemorrhage, from the external iliac artery, which was divided in the wound.⁵

Private Winny Abbott, Co. K, 25th U. S. Infantry, committed suicide at Jackson Barracks, New Orleans, August 8, 1869, by shooting himself with his own musket. The ball entered the abdomen two inches above the pubis, and one inch to the left of the linea alba, passing through the rectus abdominis muscle, cutting off the bowel, severing the external iliac artery, and escaping posteriorly through the os innominatum. He expired immediately after receiving the wound.⁶

Corporal R. A., Co. E, 38th U. S. Infantry, aged 35, was admitted to the post hospital at Fort Hays, Kansas, October 21, 1867, in an intoxicated condition, with a gunshot wound of the abdomen; pulse small and feeble, skin cold; was very restless, and vomited several times. Death resulted at two o'clock next morning. *Autopsy*—Thirty-six ounces of fluid tinged with blood, a quantity of coagulated blood, and some fecal matter were found in the abdominal cavity. The ball had wounded the small intestines in two places, passed through the sigmoid flexure of the colon, severed the external iliac artery completely, and the vein partially, etc., and lodged in the gluteal muscles.⁷

In the next two cases the femoral artery and vein were divided:—

Henry C. Clinton, artificer, Co. C, 2d Infantry, was shot in a street-brawl at Louisville, Ky., October 19, 1868, through the right thigh, by a round pistol-ball, which

¹ Ibid., p. 21.

⁴ Ibid., p. 23.

² Ibid., p. 22.

⁵ Ibid., p. 55.

⁶ Ibid., p. 55.

³ Ibid., p. 23.

⁷ Ibid., p. 55.

passed obliquely through from behind, severing the femoral artery and vein at the point where the artery passes through the adductor magnus. Death occurred in a few minutes from hemorrhage.¹

Private William Neff, Troop B, 9th Cavalry, was admitted to hospital at Fort Stockton, Texas, in a moribund condition, having bled almost to death from a gunshot wound of both thighs. A tourniquet was put over each femoral artery. The patient's condition precluded an operation for ligating the injured vessels. The autopsy showed the femoral artery and vein to be severed.²

Thus, I have briefly presented *nine* cases in which large arteries were completely divided by rifle or pistol-balls. *Eight* of them perished from the primary hemorrhage. In some, death was almost instantaneous; in others, it occurred in some minutes; and in a few at the end of some hours; but, in almost all, death occurred in a very short time. Digital compression applied in the wound immediately after the casualty, and continued until the ends of the severed artery can be securely tied, affords almost the only means of saving such patients.

But *one* of these nine cases survived the primary hemorrhage. He lived until the eighteenth day, when secondary hemorrhage supervened, and carried him off almost immediately. In the following example, also, death ensued from secondary hemorrhage:—

James Brown, 3d Tennessee Mounted Infantry, was shot through the right thigh, just below Poupart's ligament, obliquely from before backward, at the battle of Chickamauga; the wound involved the track of the femoral artery, but not the bone. The man was taken to the field hospital; no pulsation could be felt below the wound, and it is therefore believed that the common femoral artery was divided; there was then no bleeding of consequence, so the case was left to nature, and the patient did well for six days, when hemorrhage suddenly supervened while he was at stool. Liquor ferri persulph. was immediately injected into the wound, and compression applied, but without success. The external iliac artery was then ligatured, under chloroform, by Sir A. Cooper's method. But the patient never rallied from the loss of blood; he gradually sank, and died from anæmic exhaustion on the seventeenth day after the operation.³

For secondary hemorrhage in such cases, digital compression, applied without delay in the wound, and kept up until the ends of the severed artery are secured with ligatures, is the proceeding which must be employed, for it is about the only one that can rescue the patient.

Gangrene has often been observed in patients who had survived the shock and the primary bleeding incident to the division of large arteries by small-arm projectiles, and I shall present several examples in point:—

Private C. Gross, Co. K, 6th Pa. Cavalry, wounded May 30, 1864. A minié-ball passed through both thighs at the middle, from left to right, dividing also the left femoral artery, but without injuring the bone. Patient lay in the woods for twenty-four hours; hemorrhage occurred several times, which he partially controlled by making pressure with his fingers. May 31 he was discovered, and taken to the field hospital, where the severed artery was cut down upon, and both ends tied. June 4, he was admitted to Stanton Hospital, under my care; countenance pallid; pulse weak; limb very much swelled, cedematous, and presenting dark patches of extravasated blood around the groin. On the 5th secondary bleeding occurred to moderate extent, and was arrested by ferri persulph., etc. It recurred, and was arrested by digital compression. On the 8th his foot became gangrenous, and the gangrene spread upward. On the 9th he died. *Autopsy*—Limb very much swollen; muscles extensively infiltrated with pus from groin to knee; femoral artery severed about its middle; both ends tied, but the distal ligature had slipped off; femoral vein also found liga-

¹ Ibid., p. 78.

² Ibid., p. 85.

³ U. S. Sanitary Commission, Surgical Memoirs, vol. i. p. 51. New York, 1870.

tured with a separate thread. All the viscera were normal.¹ The gangrene appeared on the tenth day after the casualty.

Dr. J. C. Baylor, of Norfolk, Va., has reported another example: J. W. Dinguid, wounded by a minié-ball on June 1, 1864. Femoral artery severed in its lower third; no consecutive hemorrhage; died on the 15th, fourteen days after the injury. *Autopsy*—Gangrene of foot had commenced; wound in thigh a sloughy mass; no effort at repair.²

In both of these cases the gangrene was late in making its appearance: in the first on the tenth, and in the last about the thirteenth day after the casualty. Both patients appear to have been sunk into so low a state from anæmic exhaustion that amputation was not admissible when gangrene set in.

In the next four examples the severance of the *popliteal artery* was followed by gangrene in three instances:—

Private James H. Dutcher, 2d N. Y. Heavy Artillery, aged 24, was admitted to Stanton Hospital, under my care, June 4, 1864, from the field, having been wounded on May 31 by a conical musket-ball which passed through his left knee from before backward, and involved the track of the popliteal artery. Being very low, and the leg already gangrenous, he was placed on supporting treatment to prepare him for successful amputation, if possible. June 5—Foot and leg greatly swelled, dark-brown in color, and emitted an offensive, gangrenous odor. Thigh much swollen and hot; also extensively ecchymosed, and the swelling extends up to the groin. No line of separation yet appears. Countenance pale and anxious, pulse frequent and weak; general debility great. He was perfectly clear-minded, and expressed a strong desire to have the gangrenous limb removed. I accordingly at once, under ether, amputated it high up in the upper third of the thigh by the flap method; femur sawed off three-fourths of an inch below the trochanter minor. The shock of the operation was very great; reaction established with difficulty, and not complete until the next day. Dissection of the amputated member showed that the popliteal artery was completely divided by the bullet, just above its termination in the anterior and posterior tibials. June 6—He is feeble, pale, and anæmic. June 7—Condition unchanged; pulse about 90, and weak, notwithstanding that he receives all possible support from nutrients, tonics, and stimulants. June 8—No improvement; stump sloughy. He sank and died at 11 P. M. He also had obstinate vomiting with hiccough on the last day.

The hemorrhage in this man's case ceased spontaneously. It must, however, have been considerable, for it left him in a state of anæmic exhaustion from which he never recovered. His death, too, was hastened by septicæmia; or by the fact that his system was contaminated with the decomposing fluids which readily passed into it from the gangrenous leg, as no line of separation formed between the dead and the living tissues.

Private Sam. C. McCreary, 100th Penna. Vols., aged 24, was wounded at Chantilly, Sept. 1, 1862, by a ball which passed through the right popliteal space, having entered about three inches above the insertion of the biceps flexor cruris, passed immediately behind the femur, and emerged through the inner hamstring muscles, chipping out a small piece of the inner condyle, and dividing of course the popliteal artery. He lost a great deal of blood on the field, but the hemorrhage ceased of itself. On the fourth day afterward, he entered hospital at Alexandria, Va., in a very feeble condition and presenting an ensanguinated appearance; no pulsation in either tibial artery, and the leg itself cold. Gangrene followed, beginning at the toes. On Sept. 13, the limb was amputated four inches above the knee, under chloroform, by the flap method. For nearly three weeks after the operation, the patient's life was almost beyond hope; there was almost total anorexia, and large bed-sores formed about the sacrum. Under stimu-

¹ Ibid., pp. 53, 54, 57.

² American Journal Med. Sciences, 1865, p. 254.

lants, tonics, and nutrients, however, the patient slowly recovered, and on Dec. 4 left the hospital with his father, the stump being nearly healed.¹

The above is the almost exact prototype of a case of wound of the popliteal artery, which occurred at the battle of Chickamauga, with similar treatment and results.²

Private W. D. Thompson, Company E, 5th Cavalry, aged 40; gunshot wound (minié) of left knee-joint, ball entering outer portion of popliteal space, traversing inner condyle, and emerging at inner side of joint; popliteal artery completely divided; no consecutive hemorrhage; no effort at repair in the wound. Wounded May 5, died May 18, thirteen days after the casualty. Case reported by Dr. J. C. Baylor, of Norfolk, Va.³

Thus, I have briefly presented four cases in which the popliteal artery was severed by minié-balls. In all of them the hemorrhage ceased spontaneously; but in each the loss of blood appears to have been great, and to have caused anæmic exhaustion. In three of them gangrene of the foot and leg occurred in consequence of the arterial wound. In the remaining case, if gangrene did not appear, the fatal issue was probably due to anæmic exhaustion. Amputation of the thigh saved two of the three patients attacked with gangrene. But why is gangrene so apt to follow the severance of the popliteal artery by small-arm projectiles? The anatomical structure of the parts furnishes a good reason. When the popliteal artery has been divided in a gunshot wound, the foot and leg must derive their supply of nutrient blood through the collateral channels, which are the several articular branches at the knee, and they are so small as to afford, at best, but very scanty facilities for establishing a collateral circulation. But, in cases of gunshot wounds involving the popliteal space and parts bordering thereon, the inflammatory swelling, which always attends such wounds in this region, diminishes still further the supply of nutrient blood to the foot and leg by compressing the collateral channels at the knee; at least, the compression exerted by this inflammatory swelling is very liable to prevent the collateral channels at the knee from undergoing that development or expansion of calibre which is requisite in order to furnish such a supply of nutrient blood to the foot and leg as will preserve their vitality after the popliteal artery is severed. Gunshot wounds dividing the popliteal artery must therefore be classed among the most troublesome as well as among the most dangerous wounds in surgery. In order to achieve a successful treatment of such cases, the indications are twofold: First, the primary bleeding must be arrested at the outset, so that the occurrence of exhaustion from the loss of blood, or anæmic exhaustion of a fatal character, may be prevented, by the employment either of digital compression, or of Esmarch's elastic ligature. Secondly, the leg should be amputated at the knee-joint, during the primary period, before the patient becomes worn out by his sufferings, and before gangrene of the leg, with its attendant septicæmia, has occurred.

I shall next relate two cases in which the *posterior tibial artery* was severed by cylindro-conoidal musket-balls. In one of them there also was fracture of the fibula; in the other the bone was uninjured. In both, however, the arterial wound was the principal lesion. In both traumatic gangrene occurred. In both, likewise, the primary hemorrhage ceased spontaneously.

Private Conrad Kogel, Co. D, 15th U. S. Heavy Artillery, aged 39, was admitted to Stanton Hospital, under my care, June 4, 1864, having been wounded at Mechanicsville, May 30, by a minié-ball, which passed nearly transversely through the calf of his right leg, from without inward, and somewhat upward. When admitted, his leg

¹ U. S. Sanitary Commission Surgical Memoirs, vol. i. pp. 57, 58. New York, 1870.

² Ibid., p. 58.

³ American Journ. Med. Sciences, 1865, p. 254.

was very much swelled and inflamed up to the knee. No tibial pulse could be felt at the ankle. He had much constitutional disturbance, and was very restless. The ice-dressing was applied to his leg; nutrients and tonics were administered. June 6—Leg still more swelled, and beginning to mortify in spots; constitutional state worse, and there is irritative fever of a low type. Amputation being the only resource left, it was without delay performed at the lower third of the thigh, under ether, by the circular method. The shock was moderate, and the patient reacted promptly. Examination of the amputated member showed the posterior tibial artery divided by the bullet. The operation afforded much relief until June 10, when the flaps began to slough. He then sank into a so-called typhoid condition. June 15 (evening)—He had a pyæmic chill, after which he sweat profusely. June 16—He had two rigors, and the sweats continued. His countenance had become sallow, and he was delirious. In the evening he died. The *autopsy* revealed the lesions belonging to gangrenous osteo-mylitis and pyæmia, a description of which want of space excludes.

Lieutenant-Colonel W. G. Delaney, a prisoner of war, was admitted to Stanton Hospital, under my care, September 25, 1863, having been wounded on the 23d by a conical musket-ball, which entered his left leg on the outer side, about two inches below the head of the fibula, fractured that bone with comminution, and emerged, after crossing the track of the posterior tibial artery a short distance below its origin. The casualty was attended with considerable hemorrhage, but this ceased spontaneously, and did not return. When admitted, the patient had considerable fever of an irritative type, some œdematous swelling of the leg, and no pulsation in the posterior tibial artery at the ankle. The swelling of the leg increased, and gangrene ensued, but the patient's general condition was so bad as not to warrant the performance of amputation. On Oct. 2 he died. The *autopsy* showed the posterior tibial artery to have been completely divided by the bullet, about one inch below its origin at the bifurcation of the popliteal; there was fracture of the fibula with considerable comminution. No line of separation had been formed.

Wounds inflicted by cylindro-conoidal musket-balls which sever the posterior tibial artery in the upper third of the leg, are often, perhaps generally, attended with consecutive gangrene. The reason is twofold: first, the division of the artery cuts off the supply of blood which is needed by certain parts of the limb. Secondly, the inflammatory swelling attending such wounds is always great, especially when the arterial wound is complicated with fracture. This swelling involves the tissues which are covered or bound down by the deep fascia of the leg, as well as those external to it. As this fascia is very strong, and cannot give way, the inflammatory tumefaction beneath it compresses the anastomosing branches to such extent, and with such force, that a collateral circulation cannot be established, and thus the parts below perish from want of nutrient blood. Wounds such as these demand that amputation at the knee-joint shall be performed either primarily, or as soon as gangrene presents itself in the toes or foot. If the operation be delayed after the appearance of gangrene, the risk of septicæmia will be correspondingly increased.

In the following example, the *axillary* artery was divided by a cylindro-conoidal musket-ball; the hemorrhage was not troublesome, but gangrene of the hand, forearm, and arm ensued, and destroyed the patient:—

Private T. H. Hudson, a prisoner of war, aged 21, was admitted to Stanton Hospital, under my care, May 18, 1864, having received two wounds from minié-balls at Spottsylvania, Va., on the 11th. One of them entered his left shoulder from behind, and escaped in front a little way below the clavicle, having crossed the course of the axillary artery. The other penetrated his right hip near the sacrum, and emerged in front near the right groin. The hemorrhage was not troublesome from either wound. On admission, the patient's condition was good, and his wounds looked well. It was observed that there was no brachial nor radial pulse on the left side, and it was supposed that the left axillary artery had been severed. May 22—The wounds

appear to be doing well, but the left hand, forearm, and lower part of arm have become much swollen and dark in color. No pulsation in brachial, radial, and ulnar arteries. May 28—The gangrene is still progressing, and the mortified tissues of the forearm are exulcerating. June 1—The gangrene is limited at middle of arm. The gunshot wounds look well, but still the patient is obviously failing; he is emaciated; appetite poor; tongue dry; some diarrhoea. He continued to sink, and on June 6 he died. At the *autopsy*, the axillary artery was found completely divided by the bullet, and its two ends retracted or separated two inches from each other. Both ends were securely plugged up. The axillary vein and the brachial plexus of nerves were not wounded.

Although this patient's general condition was so bad that amputation did not seem justifiable at any time after gangrene appeared, still, on reviewing the case now, I am inclined to think that the operation might have somewhat improved his chance of recovery, especially if it had been performed in the upper part of the arm as soon as the gangrene presented itself in the hand. This plan of treatment I now recommend, and shall hereafter follow, namely, that, when gangrene occurs in consequence of division or obstruction of the axillary artery, amputation is to be practised in the upper third of the arm as soon as the hand is attacked.

The hemorrhage not unfrequently ceases spontaneously in cases where the axillary artery is divided in wounds made by musket, carbine, or pistol-balls. I shall relate another example which came under my own observation, in speaking of traumatic aneurism. The elder Larrey reported the case of General Dulong, who was wounded in the right axilla by a small-arm projectile. Although there was scarcely any hemorrhage, there was good reason to believe that the axillary artery had been divided. Dr. James M. Holloway¹ records a case in which a minié-ball passed through the left axilla from behind forward, crossing the track of the axillary artery. The bleeding ceased spontaneously, although there is good reason to believe that the artery was severed. That which was found on autopsy to have occurred in Hudson's case, related above, shows how the natural hæmostasis may succeed in such cases. The tunics at each end of the divided artery retract, recurve, and contract, whereby the orifices become much smaller, and a secure lodgment is afforded for the occluding plugs of clotted blood. "M. Verneuil communicated to the Surgical Society of Paris five cases of injuries of large arteries by balls and pieces of shell, in which hemorrhage was arrested spontaneously. The performance of primary amputation allowed the state of the vessels to be examined. The arterial coats were divided throughout on the same level as if they had been cut by a knife, and clots extended for some way above the divided ends of the vessels. In two of the cases the posterior tibial and the popliteal were the injured vessels."²

In the following example the *brachial artery* was severed in a wound made by a musket-ball. The primary bleeding was so slight as to escape mention. Eighteen days afterward secondary hemorrhage supervened, and was permanently arrested by securing both ends of the severed artery with ligatures.

Private W. J. Beverley, Co. C, 17th Maine Vols., aged 27, was admitted to Stanton Hospital May 23, 1864, on account of secondary hemorrhage from a gunshot wound of his right arm, with which he had been attacked in the streets of Washington while on his way homeward on furlough. On May 5, at the battle of the Wilderness, a musket-ball had penetrated his right arm just above the flexure of the elbow, and, passing behind the biceps muscle, had escaped on the inner side of the arm, without injuring the bone or causing much loss of blood. The secondary hemorrhage was arrested by pressure applied to the seat of injury. On the evening of the 24th, however, it returned. The brachial artery was then cut down upon at the seat of injury, and found completely

¹ American Journal of the Medical Sciences, October, 1865, pp. 352, 353.

² Gaz. Méd., Juillet 22, 1871, and New Syd. Soc. Biennial Retrospect, 1871, 1872, pp. 263, 264.

divided by the projectile. Both ends of the vessel were securely ligatured, and the hemorrhage did not recur. May 26—A slight recurrent pulse can be felt in the radial artery. June 16—The wound of operation has healed, but purulent matter has extensively burrowed among the muscles of the forearm, necessitating an incision about six inches long to relieve the burrowing. Pyæmia supervened, and, on July 2, the patient died of pyæmic pneumonia. The *autopsy* showed visceral abscesses in the lungs, liver, etc.

Two additional cases in which the brachial artery was divided in wounds made by musket-balls, are recorded in the U. S. Sanitary Commission's Surgical Memoirs, vol. i. In one of them the missile struck the left arm near the junction of the upper and middle thirds, severed the artery, and shattered the humerus for four inches; for a moment or two the bleeding was profuse, but it ceased spontaneously. The arm was amputated, two inches below the head of the humerus, four hours after the casualty. The patient recovered. In the other case, the ball passed through the anterior and inner aspect of the right arm, and directly across the course of the brachial artery. When brought to the field hospital there was no pulsation at the wrist; sensation and motion were impaired. There had been no hemorrhage excepting slight capillary oozing. No pulsation was detected by passing a finger into the wound. The shock was very great, with tendency to syncope. No secondary bleeding occurred, and the patient got well without giving much trouble.¹

In neither of these three cases of complete division of the brachial artery by musket-balls was the primary hemorrhage excessive. It was suppressed in each instance, also, with great promptitude, by the processes of nature.

Arteries of medium calibre, that is, belonging to the next subdivision after the brachial, very often, perhaps generally, cease spontaneously to bleed when completely divided in wounds made by musket-balls, etc., as happened with the internal epigastric arteries in the following instance:—

A prisoner of war was shot by the guard while attempting to escape. The bullet went into one inguinal region and emerged from the other, cutting through the entire abdominal wall, from side to side, about half an inch above the pubis. It severed the epigastric artery on either side (the ends were visible), and produced a gaping wound about eight inches in length, plainly exposing the pelvic viscera. There appears to have been no bleeding. Three weeks afterward the patient was returned from the hospital, convalescent, to the military prison.²

But the bleeding does not always cease spontaneously in such cases, as the following example shows:—

Private A. Y., Co. D, 23d Infantry, received a severe gunshot wound of the wrist-joint, in a skirmish with Indians, April 29, 1868. The radial artery, being lacerated, was ligated above and below the seat of injury, and water dressings were applied to the wound. In July, 1868, the patient returned to duty.³

The observations presented above show that gunshot wounds dividing large arteries are not only very dangerous, but also destroy life in certain determinate ways, the principal of which are primary hemorrhage, secondary hemorrhage, and consecutive gangrene. Gangrene ensues after such wounds much oftener than many suppose; I have presented eight examples of it, five of which passed under my own observation, and have seen several other examples of which unfortunately I did not take notes.

As this subject (traumatic gangrene) possesses much importance in this connection, I have taken some pains to collate Guthrie's experience concerning gangrene following gunshot wounds of bloodvessels. It appears that he saw seven cases belonging to this category in military practice. In three of

¹ Op. cit., pp. 69, 70.

² Med. and Surg. History of the War, Second Surg. Vol., p. 175.

³ Circular No. 3, S. G. O., pp. 237, 238.

them the popliteal artery was involved. In two of these three cases it was found, on dissection, that there was complete division of the artery; in the other case it was surmised that there was complete division of the artery, but no autopsy was made. In the remaining four cases it was believed that the femoral artery was wounded by a musket-ball in every instance; but it was not known that the artery was completely divided in any of them. Of these seven cases observed by Guthrie, then it appears that, as far as known, the vessel was completely divided in but two instances, both pertaining to the popliteal artery. Amputation was resorted to in two instances, but without avail. Every one of these seven cases proved fatal.¹

Guthrie also stated that he had seen, in London, three cases of gangrene following wounds of the femoral and popliteal arteries; in two the popliteal, and in one the femoral was the injured vessel. All proved fatal from the extension of the gangrene.²

The principal cause of the great fatality which attends traumatic gangrene, is the fact that a line of demarcation, or separation of the dead from the living tissues, is but seldom formed in such cases. This circumstance is also noticed by Guthrie. The consequence is, that the veins which proceed from the gangrenous part toward the trunk, not being closed or obliterated as they would be if a line of separation were formed, convey the decomposing blood and other putrescent liquids from the gangrenous part, and pour them into the current of the general circulation. Thus, systemic poisoning of a septic character, or septicæmia, is produced, and the patient's life is destroyed; and the earlier the date may be when the gangrenous part is removed from the body by amputating it, the less will be the degree of the septicæmia.

Symptoms of Complete Arterial Division.—The symptoms which indicate that a large artery that lies in or crosses the track of a gunshot wound is completely divided, are, brisk hemorrhage, and the disappearance of pulsation in the injured vessel and its branches below or beyond the wound. In cases where there is such absence of pulsation, but no hemorrhage, there may be some doubt as to whether the lesion consists of complete division of the artery, or complete obstruction of its canal from recurvation of its severed inner and middle coats or from plugging with coagulum. But such an occlusion from plugging, without division of the external tunic of the artery, is a very rare occurrence in the history of wounds made by small-arm missiles, however frequently it may be met with in cases where arteries are stretched or bruised; and it should be estimated accordingly.

Treatment.—When a large artery is completely divided in a gunshot wound, the *first indication* is to suppress the primary bleeding, without delay, by digital compression, and to restrain it in this manner until the ends can be found and secured by a carbolized catgut ligature applied to each of them. The method in which digital compression can be most effectually employed in such cases, consists in placing both index fingers, or a thumb, in the wound, and applying them directly to the ends of the bleeding vessel. In this way the hemorrhage can be arrested with promptitude, with certainty, and with but little effort; for only a slight degree of pressure is required to arrest the flow of blood, if applied directly to the bleeding orifice of the artery. I say again that, in this way, the hemorrhage from gunshot wounds involving the arteries of the neck, armpit, and extremities, may readily be controlled by any person of ordinary intelligence, until surgical assistance can be obtained, and the injured vessel can be properly ligated. Moreover, the compression,

¹ Diseases and Injuries of Arteries, pp. 235–243.

² *Ibid.*, p. 245.

to be of much use in such cases, must be promptly applied; otherwise, so much blood will be lost as to prove fatal by anæmic exhaustion, if not by syncope. Both ends of the severed artery must be tied with carbolized catgut. The following example will usefully illustrate the subject of ligating the smaller arteries which may be severed in gunshot wounds:—

Private W. Jess, Troop M, 7th Cavalry, received Nov. 21, 1868, a gunshot wound of right forearm at the middle. The ball passed between the radius and the ulna without fracturing either. No hemorrhage occurred until the fifth day; afterward, hemorrhage occurred about every twenty-four hours, generally at night, from a few ounces to a pint at a time. When the dressings were removed the hemorrhage would cease; an operation was consequently delayed from day to day, in the hope that it would be unnecessary. The arm began to swell, became painful, tense, and glossy, and from above the elbow to the shoulder was swollen and œdematous. On Dec. 5, a deep incision, four inches long, was made lengthwise at the wound. A large quantity of clotted blood was thrown out from between the muscles, which had been dissected up by it in every direction. The interosseous artery was found severed, and both ends of it were tied. The pain was immediately relieved, and the swelling rapidly disappeared. No bad symptoms occurred, and the patient was returned to duty in January, 1869.¹

The *second indication* in the treatment of cases where large arteries are divided in gunshot wounds, is to anticipate and prevent the occurrence of secondary hemorrhage. Should the ends of the severed artery be sought for and tied, in such cases, when they are not bleeding? Secondary hemorrhage when it occurs in such cases is almost always fatal; and, inasmuch as the best method of preventing secondary hemorrhage from wounded arteries consists in properly tying them, I do not doubt that, in most cases where large arteries are divided in gunshot wounds, their ends should, if practicable, be brought into view by making the necessary incisions, and carbolized catgut ligatures should be applied to both the proximal and the distal ends, although they are not bleeding at the time. Had this been done in three of the cases presented above, where secondary hemorrhage occurred and death ensued, namely, that of George Robinson, whose carotid artery was divided, that of James Brown, whose femoral artery was severed, and that of W. J. Beverley, whose brachial artery was cut across, there is good reason to believe that all of them would have been saved.

Furthermore, I hold that, in every case of gunshot injury where there is reason to believe that large arterial trunks have been damaged, even when they are not divided, a careful search should be made; and should it prove that such is the case, they should be tied with antiseptic ligatures, whether bleeding or not, to render them secure against the effects of reaction and the occurrence of secondary hemorrhage. These proceedings, and the taking care to tie the ligatures in such a way that they cannot slip off from the ends of the artery, constitute the chief surgical means of fulfilling the second indication.

The *third indication* in the treatment of such cases consists in anticipating the occurrence and obviating the effects of gangrene. Whenever the femoral, popliteal, or posterior tibial artery in the upper third of the leg is severed in a gunshot wound, there is much greater risk of the occurrence of gangrene than of secondary hemorrhage; and gangrene is more fatal than even secondary hemorrhage in such cases. For out of eighteen cases of gangrene caused by gunshot wounds of arteries, related or referred to above, all ended fatally save one, and in this the patient was saved by amputation. The great danger of this form of gangrene is because of the very great liability to the occurrence of septicæmia from the non-formation of a demarcating line, as I have just shown

¹ Circular No. 3, S. G. O., p. 238.

above. The only way to obviate the deadly consequences of such a gangrene, and notably the septicæmia, is to remove the mortifying part by amputating the limb at the summit of the region deprived of nutrient blood by the arterial wound; and, the earlier the operation is performed, the less the degree of septicæmia, and the greater the hope of a successful issue. Hence, as soon as the toes become gangrenous in consequence of a severance of the posterior tibial or the popliteal artery, the leg should be amputated at the knee-joint; or, if in consequence of a severance of the femoral artery, the thigh should be amputated above the seat of the arterial lesion. In the upper extremity, as soon as the fingers mortify in consequence of a gunshot severance of the axillary artery, the arm should be amputated at the shoulder-joint or within two or three inches thereof. It is a still better practice, however, to remove by primary amputation the parts in which we know from experience that gangrene will almost certainly ensue; for instance, in cases of gunshot severance of the popliteal artery, or of the posterior tibial in its upper third, especially if the bone be also implicated, primary amputation ought generally to be performed. Under a policy of delay in such cases, gangrene almost always ensues. Primary amputation, by anticipating and averting the occurrence of gangrene and septicæmia, gives the patient the best possible chance to recover.

When gunshot severance of the femoral artery is complicated with gunshot fracture of the thigh bone, I believe it is always best to amputate without delay, because gangrene is almost certain to ensue if the limb be not cut off, and because amputation in the primary period is much more likely to prove successful in such cases than amputation performed in the inflammatory period, or after the appearance of gangrene. When gunshot severance of the posterior tibial artery is complicated with gunshot fracture of both bones of the leg, I believe it is generally preferable to employ primary amputation, especially in military practice in the field. In civil life, however, where the circumstances are usually much more favorable for conducting the after-treatment, it may be advisable to attempt to save the leg when the comminution is not extensive, and the laceration of the soft parts not great, and especially if only one bone be broken. In such a case, occurring under circumstances favorable for treatment, it may be advisable to tie both ends of the artery in the wound, and then to treat the case as a gunshot fracture, with antiseptic dressings.

When gunshot severance of the brachial artery is attended by gunshot fracture of the humerus, the chances of treating the case successfully, without amputation, are generally much greater than in corresponding lesions of the lower extremity. When the broken humerus is but little comminuted, the soft parts surrounding it but little torn, and the accompanying nerves uninjured, it is generally advisable to tie both ends of the artery, and attempt to save the arm. But when the comminution is extensive, and the laceration of the soft parts great, the brachial artery also being severed, primary amputation should be performed. In gunshot fractures of the forearm associated with corresponding wounds of arteries, however, it is but seldom necessary to amputate, unless the elbow-joint be implicated; in such a case it is generally advisable to amputate without delay.

Again, when a gunshot wound of the femoral or popliteal artery is attended with a corresponding lesion of the vein and nerve, although the bone be uninjured, primary amputation should always be performed.

Antiseptic dressings should always be employed, and thorough drainage of the wound should be secured by using Chassaignac's drainage-tubes, etc., in all cases where arteries are involved in gunshot lesions.

The inapplicability of styptics, such as the persulphate and the perchloride of iron, etc., to the treatment of hemorrhage from gunshot wounds of arteries, has already been pointed out. (See page 625.)

INCISED WOUNDS OF ARTERIES.

The incised wounds of arteries are inflicted with knives of various sizes and shapes, with sharpened swords or sabres, and with many of the edge-tools used in the mechanic arts. A sharp cutting instrument cleaves the tissues with the least possible disturbance of their histological elements, and leaves the opposing surfaces of the section or wound smooth, even, or level, and in the best possible condition for speedy and perfect reparation. But the same circumstances favor the outflow of blood; for the smoothly divided vessels present no such mechanical obstacles to hemorrhage, at their open mouths, as are seen in most other wounds. The incised wounds of arteries are inflicted in accidents, with design, and in war.

When arteries are invaded by cutting instruments, the lesion consists either of a complete division of the arterial tube, or of a partial division, or of a division of the sheath and the external tunic only, or of a mere puncture of all the arterial tunics. But the punctured wounds of arteries are often caused by instruments other than cutting ones, and therefore this form of injury constitutes a separate class, which we have already attentively considered.

The incised wounds of arteries are more prone to bleed than the contused, or the lacerated, or the gunshot wounds, for reasons just stated above. The hemorrhage but seldom, if ever, ceases spontaneously when large arteries are severed by sharp-edged instruments, unless death is at hand, and there is no longer any blood to flow away. But the bleeding from the contused, and the lacerated, and the gunshot severance of arteries, having a similar size, not unfrequently stops of itself, as we have already shown. Incised wounds of arteries are characterized as a class by excessive hemorrhage; and they are more liable as a class to produce death by primary bleeding than any other form of vascular injury.

When a small artery is but partially divided by a cutting instrument, it is always more difficult to stanch the hemorrhage than it is when the same vessel is completely divided. Thus, in abstracting blood from the temporal artery (arteriotomy), when it becomes necessary to stop the bleeding, the first thing to be done is to completely divide the artery at the place where it has been opened, and then a moderate amount of pressure applied for a short time at the place of division will generally suffice to permanently suppress the bleeding. But, if the division of the artery be not made complete in such a case, if pressure be applied for the purpose of arresting the outflow of blood while the arterial tube is only partly divided, then it generally follows that either a traumatic aneurism is formed in the wound, or secondary hemorrhages successively ensue, which may place the patient's life in great peril, even where an artery as small as the anterior branch of the temporal is the vessel involved in the lesion. In cases of incised wounds in general, where the hemorrhage from small arteries that are but partially divided gives trouble, the first thing to be done for suppressing it is to complete the division of the bleeding vessels. Thus we perceive that the treatment of the incised wounds of arteries must be conducted on principles somewhat different from those which obtain in treating the contused, the lacerated, and the gunshot wounds of arteries.

The two following examples usefully illustrate what takes place when a

large artery is completely divided in an incised wound, and the case is left to Nature:—

William Barren, a sailmaker, aged about 32, was stabbed in the throat, and in other places, in an affray, on Saturday night, December 11; he bled very profusely from the throat-wound, and expired in about twenty minutes from the hemorrhage. *Autopsy*, at the Fourth Ward Station-house, December 13, by the author, at twelve M.—Face, lips, gums, and surface of whole body pale and exsanguinated. On left side of neck was found an incised wound, two and a half inches in length, commencing anterior to the ear, and extending forward and somewhat obliquely downward, just beneath and nearly parallel to the body of the lower jaw; its lips were drawn together and held by one suture; the lips of the wound were somewhat irregular in shape; the track of the wound extended almost transversely across and nearly through the throat, severing, in its course, the anterior third of the sterno-mastoid muscle, the left *external carotid artery* near its origin, and the accompanying vein; it also passed through the muscles at the root of the tongue, cutting off the epiglottis at its base; it divided the great cornu of the hyoid bone on the right side, and terminated near the anterior margin of the right sterno-mastoid muscle. Some clotted blood was found in the larynx below the rima glottidis. The stomach contained a few ounces of a substance resembling coffee-grounds. Internal organs generally exsanguinated, but otherwise sound.

The ends of the severed external carotid artery were somewhat contracted, but still permeable, and not plugged up with coagulated blood. The wound in the neighborhood of the vessel contained clotted blood. (The parts of the record not pertinent are omitted.)

John Heavy, middle-aged, was cut in the upper and inner part of his right arm with a knife, and died from the hemorrhage in fifteen or twenty minutes—in not less than fifteen nor more than twenty minutes—on the night of May 3. *Autopsy* by the author, at the Fourth Ward Station-house, on May 4, at 4 P. M.—Cadaver large and muscular; face, lips, and surface of body generally very pale, and presenting a waxen appearance. There was an incised wound of the integuments on the antero-internal part of the right arm, just below the fold of the armpit, one inch and a quarter in length, and extending obliquely across the arm. It was about two inches in depth, and involved the *brachial artery*, which had been severed transversely near its origin. The ends of the divided vessel were partially contracted, but not plugged up with coagulated blood. The wound of the soft parts exterior to the vessel was filled with clotted blood. The lungs, liver, spleen, and internal organs in general, contained much less than the normal quantity of blood; heart large and fatty, with some blood in its right cavities. (Some immaterial points are omitted.)

In neither of these cases was any effort of importance made to suppress the bleeding. The largeness and smoothness of the gash in the integuments and other parts exterior to the artery, allowed the blood to escape unobstructedly from the arterial lesion, in both instances. Careful inquiry was also made by the author, for the purpose of ascertaining how long each man lived after he was stabbed. As both cases were thoroughly investigated by the coroner, unusual facilities were afforded for pursuing this inquiry. The witnesses agreed in testifying that in the external carotid case the man expired in about twenty minutes, and in the brachial artery case in fifteen or twenty minutes—in not less than fifteen nor more than twenty minutes—after the gash was made. In both instances the ends of the severed arteries were somewhat contracted, but they were still open, and not filled or plugged with coagulated blood. In each instance, however, the gash in the soft parts exterior to the vessel was filled with clotted blood. In such cases, as the pulsations of the artery become weaker and the coagulability of the blood increases, the external wound becomes filled with a coagulum, in the middle of which a channel remains open, through which the blood continues to trickle until the clot becomes stronger than the current of the blood, that is,

until the clot coheres with more force than the impulse which the blood receives from the almost empty artery; but when the hemorrhage thus ceases, death is usually very near.

How can such arterial wounds be successfully treated? In cases where either of the *carotids* is involved, pressure must be applied, without delay, by both index fingers or a thumb, in the wound, to the ends of the orifice in the wounded artery, until it can be securely tied with carbolized catgut, above and below the lesion. (Consult also on this point the case of a miller, stabbed in the neck with a pocket-knife, who was successfully treated on this plan, p. 561; and the remarks on the treatment of punctured wounds of arteries on p. 567.) In cases where the *brachial artery* is opened by an incised wound, the bleeding must be promptly suppressed by digital compression, or by an extemporaneous tourniquet, or by Esmarch's elastic ligature, until the artery can be tied above and below the wound. In the following instance this was done with tourniquets extemporized with pocket handkerchiefs:—

An insubordinate soldier, aged 26, while in liquor, resisted arrest and attempted to use violence, whereupon one of the provost guards stabbed him with his sword in the upper part of the left arm, the wound corresponding to the lower third of the coracobrachialis muscle. Profuse hemorrhage followed, and was arrested by the corporal of the guard, who applied a handkerchief tightly above and another below the wound. This was so cleverly done that the patient lost no blood until the dressing had been removed two hours subsequently, Sept. 20, 1861, when he was conveyed to the hospital for treatment. On careful examination, the *brachial artery* was found wounded; without further delay an incision was made as for ligature of the artery, and the vessel secured above and below the wound, and the portion between the two wounds cut out. The *venæ comites* were also tied because they were wounded. With the exception of considerable œdema of the hand, forearm, and arm, which was controlled by bandages, the case progressed well. On Oct. 16, the patient was returned to duty, entirely well.¹

In this case, the first or proximal ligature having been applied, the wound was carefully sponged, and red blood was distinctly seen jetting out of the mouth of the vessel from below, and that with considerable force, showing that the application of a ligature to the artery above the wound only would have been an insufficient and an incomplete operation. The arterial wound consisted of a gash which extended about half way across the artery, in a nearly transverse direction, and was situated about one inch below the origin of the artery. The weapon penetrated the limb in an oblique direction. The incision of the skin was about one inch long. On loosening the extemporized tourniquet, the hemorrhage did not recur; the wound was filled with coagulated blood; but it was found that there was no radial, nor ulnar, nor brachial pulse. The nature of the injury, therefore, could not be mistaken. But the ocular demonstration of regurgitating distal hemorrhage was, perhaps, the most interesting part of the case.

The history just related affords a capital illustration of what the treatment should be in cases where the main artery of an extremity is opened by an incised wound, namely, the arrest of hemorrhage, without any delay, by applying digital compression in the wound, or a tourniquet, or an elastic ligature above and below the wound temporarily, that is, until surgical aid can be obtained, and the artery tied properly above and below the gash in its coats. In the following example, although the compression was continued for eighteen days, the operation for applying ligatures had to be performed in order to obtain a cure:—

¹ Med. and Surg. Hist. of the War, Second Surg. Vol., p. 436.

A man, aged 36, accidentally stabbed himself with a pocket-knife toward the inner side and a little below the middle of the left thigh. There was a profuse escape of arterial blood, and he fainted. He was treated by compression for eighteen days, and brought to hospital on March 8. There was found some swelling surrounding an aperture in the skin an inch long, rounded in form, and situated as above stated. The tumor was hard, and did not pulsate. On the 12th, sharp hemorrhage suddenly occurred to the extent of an ounce or two. On the 16th, a pulsating tumor having formed at the seat of injury during the past two days, the artery was cut down upon by enlarging the wound, and tied, under chloroform. A large quantity of firmly laminated fibrin was turned out. The artery was compressed on the pubis by a finger during the operation. But little blood was lost, and recovery, though somewhat tardy, followed.¹

One or two additional examples, briefly narrated, will impart more information concerning the treatment of this most formidable lesion of the femoral artery than a lengthy disquisition:—

Private George Hastings, Co. K, 37th Infantry, was admitted to hospital July 30, 1868, having been accidentally stabbed the same day, in the upper part of the thigh, with a long, narrow, exceedingly sharp hunting-knife, which, passing by the superficial *femoral artery*, partially divided the *profunda femoris* below the origin of the external circumflex. The hemorrhage was excessive. Some few moments only elapsed after the accident before complete syncope ensued. Pressure on the common femoral arrested the hemorrhage, but the prostration was so extreme as to prohibit operative interference at the time, and stimulants and nutriments were administered. At 10 o'clock P. M., hemorrhage again occurring, now from the lower or distal extremity of the artery, the wound was enlarged and the *arteria profunda* secured with ligatures above and below the lesion. The patient was kept for several days under the influence of morphia. Slight pressure continued on the common femoral, although not sufficient at any time to greatly impede the circulation in the limb. At no time after the operation was the circulation arrested. On the nineteenth day the upper ligature was removed, but the lower one did not come away until the thirty-fourth day. The patient recovered completely, and was returned to duty in the following October, between two and three months after the casualty.²

The following case, in which the employment of compression to temporarily restrain the first bleeding from an incised wound of the femoral artery, appears to have been neglected, has peculiar interest in this connection:—

A man, aged 53, was admitted to hospital on November 11, pulseless and faint from the loss of blood. There was a small wound, two inches below Poupart's ligament, in his left thigh, over the *femoral artery*, caused by a knife that had accidentally slipped. The bleeding, which evidently had been great, had ceased. He was placed in bed; and, as reaction came on, a pulsating swelling was revealed beneath the wound. Nov. 14—Tumor larger, and pulsation more marked. The tumor was laid open with a view to ligature the artery above and below the aperture in it. A large, gaping wound was found in the femoral artery. Much difficulty was experienced in applying the proximal ligature, on account of a large branch given off from the artery beneath the wound, which proved to be the *profunda*. After applying the proximal and distal ligatures and letting up the pressure, a fierce gush of blood from regurgitation through the *profunda* followed. This artery also was tied, and the hemorrhage ceased. The patient sank gradually, and died on the 21st, from exhaustion due to the loss of blood.³

The observations on punctured wounds of the femoral artery, and their treatment, at page 573, should also be consulted in this connection.

Incised wounds of the *popliteal artery* are not frequent occurrences; still, Deschamps has related a case:—

Etienne Repasses, a servant, aged 41, was admitted to hospital, on May 9, for a stab in the ham, inflicted with the point of a sabre, which completely divided the pop-

¹ British Medical Journal, August 3, 1872, p. 126.

² Circular No. 3, S. G. O., p. 242.

³ British Medical Journal, Feb. 13, 1875, p. 211.

liteal artery. A traumatic aneurism formed. On June 20, it was laid freely open by an incision about six inches in length, all the clots were removed, the cavity was thoroughly cleansed, and a ligature was tied around each end of the severed artery about four lines from its extremity. A deep abscess in the leg ensued, which emptied itself into the wound. The patient died on the thirty-eighth day after the operation, apparently from pyæmia.¹ The result could have been no worse if the femoral artery had been tied on the plan of Hunter, or even if amputation had been performed.

In the following instance, Hunter's operation was performed: Private David Jones, Company E, 4th Infantry, was wounded at Fort Sully, on March 7, 1866, by a soldier who made a thrust with a large bread-knife, which entered the thigh transversely, about three inches above the inner condyle of the femur, and, passing almost through, severed the popliteal artery, vein, and nerve. The hemorrhage was controlled by compression, and it was then deemed best not to open the wound and attempt to ligate the artery therein. On the fourth day, some arterial hemorrhage occurring, it was thought unsafe to delay, and the femoral was tied at the middle third. There had been no warmth nor circulation below the wound since the injury, and at the time of the operation there were strong indications of gangrene. The patient died on the seventh day after the operation, March 16.²

Although the cause of death is not expressly stated in this case, still I think that it may fairly be taken by implication to have been traumatic gangrene. In many cases belonging to this category, where gangrene is likely to ensue, it will be advisable to amputate at the outset—that is, to perform primary amputation. No one plan of treatment can be prescribed which will suit all, or even the majority of cases, when the popliteal artery has been opened by an incised wound. In some cases it will be advisable for the surgeon to expose the artery, and ligature it above and below the seat of injury; in others, to perform Hunter's operation; and in still others, to amputate the limb. Each case must be judged by itself, and that procedure selected which appears most likely to save the patient's life. The occurrence of gangrene, however, always necessitates immediate amputation in these cases.

Incised wounds of the *tibial arteries* generally, be treated on the same plan as incised wounds of the femoral and brachial arteries, just described. The hemorrhage should be restrained by compression until the injured vessel can be laid bare and tied above and below the cut in its walls. Leisrnick has made, in a case of incised wound involving the anterior tibial artery, a fortunate application of the elastic compression of Esmarch. A man having been wounded in the leg with the point of a knife, there rose up in the course of the anterior tibial artery a bluish-colored and pulsating swelling, of the size of a fist. By employing elastic compression (pp. 524-529), Leisrnick was enabled to readily apply to this traumatic aneurism the ancient method of operating; namely, to freely lay open the sac, completely evacuate its contents, and find and tie the artery above and below its open mouth.³

No doubt, in many cases where the *tibial arteries* are wounded, the elastic ligature may, with great advantage, be applied to the leg, both above and below the wound, so as to effectually control the circulation while the injured artery is being ligated on the "old plan." Boyer has forcibly illustrated the great superiority of the "old plan" of treatment in such cases:—

A young man received an incised wound involving the posterior tibial artery in the lower part of his leg, near the internal ankle. In some additional cases, the malleolar and tarsal arteries which run over the foot were likewise divided. These patients all died; they might have been saved, if, instead of stuffing the wounds with styptics and lint, the surgeon had cut down upon the arteries and tied them above and below.⁴

¹ Observations on Aneurism, Sydenham Society's edition, p. 410.

² Circular No. 3, S. G. O., pp. 241, 242.

³ Nouveau Dictionnaire de Méd. et de Chirurg. pratiques, t. xix. Paris, 1874.

⁴ Op. cit., vol. i. p. 132, Am. ed.

In the following example the *dorsal artery of the foot* was ligatured on this plan with a good result:—

Private James Lasby, Co. G, 23d Infantry, aged 33, while chopping wood at Fort Colville, on December 15, 1868, cut his right foot with a sharp axe. The flexor tendons of the foot, the *dorsalis pedis* artery, and the metatarsal bone of the great toe were divided, causing a gaping wound four inches in length. He was admitted to the post hospital, where the *dorsalis pedis* artery was ligated, and the wound closed by interrupted suture. The wound failed to unite by first intention, and, on Dec. 20, the ligature was removed. The patient was returned to duty in March, 1869.¹

Distal ligatures must be applied to wounded arteries in the foot and leg, as in the hand and arm, in order to guard against the regurgitating hemorrhage which, in their absence, would result from the remarkably free anastomoses of the terminal branches with each other by means of the plantar arches, etc., in the one case, and of the palmar arches, etc., in the other. Hemorrhage from incised wounds of the foot, ankle, and leg, when the wound is recent and the parts are sound, will give the surgeon but little trouble provided he treats it on the orthodox plan of bringing the bleeding point distinctly into view, applying a ligature on each side of it, and dividing the artery midway between the ligatures, so that the ends may retract.

During the late civil war, three hundred and fifty-seven cases of incised and punctured wounds of the upper extremities were reported. There were four deaths: two from neglected arterial bleeding, one from gangrene, and one from a fever long after the wound had healed.² Incised wounds of the *brachial* artery have already been discussed at sufficient length. The examples of *punctured* wounds of the *brachial* artery and the remarks thereon, given at page 570, should also be examined in this connection.

Incised wounds of the shoulder are sometimes attended by a tremendous hemorrhage from lesion of some branch of the axillary or subclavian artery, as happened in the following instance, where the *posterior circumflex* artery was opened:—

Private Thomas Quigley, Co. G, 17th Infantry, aged 21, received, at Sulphur Springs, Texas, on December 24, 1868, an incised wound of the left shoulder, eight inches in length, from the shoulder downward. He was admitted to the post hospital; he had fainted from the loss of blood, and his pulse was almost imperceptible. The wound was explored, and the *posterior circumflex* artery, which was found injured and bleeding, was securely tied; the edges of the wound were brought together and held by silk sutures and adhesive plaster. On December 31 the wound was healing rapidly. In February, 1869, the patient was returned to duty.³ This case usefully illustrates the plan of treatment which should be carried out in all cases of hemorrhage from incised wounds of the shoulder and arm where the lesser arteries are involved. The wound must be explored, and the bleeding vessel must be brought into plain view, and securely tied. In this way the very best possible results are obtained. But stuffing such wounds with lint soaked in the persulphate or perchloride of iron has often been attended with disastrous consequences.

How should incised wounds of the *radial*, *ulnar*, and *interosseous* arteries be treated? On this point the brief presentation of a few cases will give the requisite information in a convenient way.

When the *radial* artery is completely divided, properly adjusted compression at the wound will not unfrequently stop the bleeding permanently, as it did in a case reported by Dr. Franz in the Medical and Surgical History of the War.⁴ But this is not always, nor even generally, the best practice, and

¹ Circular No. 3, S. G. O., p. 243.

² Med. and Surg. Hist., Second Surg. Vol., pp. 436, 437.

³ Circular No. 3, S. G. O., p. 243.

⁴ Second Surg. Vol., p. 436.

when the wound is inflamed or much swollen, it cannot be employed. Much preferable to it for general use is ligation according to the ancient method, as was practised in the next two examples:—

A soldier, aged 24, received, September 22, 1868, an incised wound on the dorsal surface of his right hand, severing the radial artery. He was taken to hospital, where both extremities of the artery were ligated. On September 30 the patient was doing well; in October he was returned to duty.¹

A cavalry soldier at West Point severed the radial artery by striking his fist through a window-pane May 31, 1868. The wound was enlarged by incision, and both ends of the artery were tied by Dr. E. J. Marsh. Considerable swelling followed; the wound, however, healed with but slight suppuration. On June 9 the ligatures were removed; on the 18th the patient was returned to duty.²

The following case, in which the ancient method of ligation had finally to be practised for an incised wound of the ulnar artery, will serve to show the comparative value of several different plans of treating the consequences of this wound:—

A zinc-plate worker, aged 29, was admitted to St. George's Hospital March 6, under care of Mr. Pick. Twelve days before, a chisel slipped and entered his left wrist over the ulnar artery. Profuse hemorrhage followed; it was controlled at first by a ligature tied tightly round the arm, and subsequently by direct pressure over the wound, which was maintained for two or three days, the wound, on its removal, being found healed. In the course of a few days, however, a swelling appeared, which, on admission to hospital, was found to be oval in shape, of the size of a walnut, and situated on the wrist in the course of the ulnar artery. It was surmounted by a cicatrix. Pulsation and bruit were marked. The forearm was kept forcibly flexed upon the arm for twenty-one hours, without benefit. Two horse-shoe tourniquets were next applied, one on the brachial, the other on the ulnar artery, and were kept on as long as the patient would bear them, and until the limb was very œdematous, but without success. On April 15, galvano-puncture was applied. On the second day afterward the sac burst, and much bleeding ensued. The sac was then laid open from top to bottom, and a few clots, with some decolorized fibrin, turned out. In the posterior part of the sac the upper and lower orifices were seen. The vessel was then tied above and below, and divided between the two ligatures. The man made a good recovery.³

Had the last operation been performed at the outset, much time, much expense, much trouble, and much suffering would have been saved to patient and surgeon. Let me here say, also, that hemorrhage from incised wounds of the radial, ulnar, and interosseous arteries, or their branches, when the wound is recent and the parts are sound, will give the surgeon but little trouble, provided he treats it on the orthodox plan of bringing the bleeding orifice clearly into view, applying a ligature on each side of it, and dividing the artery midway between the two ligatures, so that the ends may freely retract. But if the surgeon rely on compression and styptics, in such cases, he may cause for himself a great deal of trouble, and for his patient a great deal of suffering, which could readily have been avoided by ligaturing the wounded vessels according to the method just described. In such cases, too, distal ligatures are indispensable in order to prevent the regurgitant bleeding which, in their absence, would ensue from the remarkably free anastomoses that exist between the terminal branches by means of the palmar arches, etc.

Incised wounds involving the *palmar arches* are not unfrequently met with. They are caused by the sharp-edged tools of industry; also by grasping with the hands, in self-defence, the razors, knives, and daggers with which assaults are made. These wounds, when treated at the outset on the orthodox plan

¹ Circular No. 3, S. G. O., p. 237.

² *Ibid.*, p. 237.

³ *British Medical Journal*, June 1, 1872, p. 582.

described above, give but little trouble. But, as the late Dr. Otis very justly remarks: "The subjects of such injuries are very unfortunate if they have not the services of a surgeon possessed of the requisite skill and courage to thoroughly explore the wound at the outset."¹ I do not say that such cuts never get well under the use of compresses and bandages; I do say, however, that compression often fails to check the bleeding permanently, and that I have seen several instances of such a failure, in some of which the patients were blanched or exsanguinated, and exhausted, from the frequently recurring hemorrhages. Professors Gross and Agnew advise that the general rule for the treatment of wounded arteries should not be deviated from here; and that in recent punctured or incised wounds of the palmar arches, the wound should be enlarged and both ends of the bleeding vessel tied. But the neglected cases present the real difficulties; and in these, compression, cauterization, acupressure, ligation of the radial or ulnar artery, or both, and ligation of the brachial artery, have all been employed with reported successes and failures. Concerning the neglected cases, Professor Von Pitha observes: "I saw several cases of exceedingly rebellious bleeding from cuts and stabs of the palm; two of these were brought to me after numerous ineffectual attempts to stop the bleeding, in a profoundly anæmic condition; yet I was never forced to practise ligation, as the bleeding ceased, on removing the coagula, completely and permanently. . . . The first thing to be done in such cases is to freely expose the bleeding vessel by enlarging the wound, and to boldly clear away all coagula. The irritation caused by the sponge and by the admission of cool air frequently induces the gaping arterial wound to retract. The wound should not be immediately closed, but should be kept under close observation for some time."² Many other surgeons, including the author, have likewise seen, in cases of recurring hemorrhage from wounds of the palm, the bleeding cease completely and permanently on laying bare the open mouth of the bleeding vessel, by enlarging the wound, completing the division of the artery in cases where it was incompletely divided, and at the same time removing all coagula and thoroughly cleansing the wound. The ends of the severed artery, which projected at first from the surface of section, have many times been seen to retract, contract, and become completely closed, so that all future hemorrhage was effectually restrained. The most important points to be considered in treating hemorrhage from wounds of the palm are: (1) To distinctly bring into view the mouth or mouths of the bleeding artery, by enlarging the wound; (2) to complete the division of the artery whenever it is found to be incompletely divided; (3) to remove all clots and foreign substances from the wound, and apply pressure to the ends of the severed artery by means of a finger placed in the wound; and (4) if the ends of the artery do not retract, contract, and become completely occluded with a supplemental internal coagulum, to place a ligature of carbolized catgut, securely, on each of the ends. In all cases, whether they be quite recent, or old and neglected, or badly treated, the bleeding artery must be sought for and found in the wounded palm. (For further information on this and other important points, examine the cases and the discussion of punctured wounds of the palmar arches on p. 571.) The objection that a search for the wounded artery may necessitate more or less mutilation of the palm should not be allowed to have much weight against the possibility of failure, as well as the danger, which, in such cases, attends upon the deligation of the arterial trunks in the forearm and arm.

Incised wounds involving the lesser arteries of the head and face should

¹ Med. and Surg. Hist. of the War of the Rebellion, Second Surg. Vol., p. 437.

² Ibid., p. 437, foot note.

be treated by removing all the coagula and exposing the aperture whence the blood issues distinctly to view, by completing the division of the artery whenever it is not complete, and by applying pressure to the ends of the divided artery with a finger in the wound. The success of this proceeding can be considerably aided by simultaneously compressing the trunk of the common carotid artery against the transverse processes of the vertebræ, on the same side as the wound (see Fig. 346, p. 518), with the thumb of the other hand. If in a short time the bleeding is not stanchd by these proceedings, a ligature must be put on each end of the wounded artery. In cases where the ligatures, both proximal and distal, have been applied without previously dividing the artery, the artery should be divided midway between the ligatures, so that retraction of the ends may take place.

The hemorrhage from incised wounds of the neck involving the occipital, vertebral, or superior thyroid artery, should be treated on the same general plan as the hemorrhage from incised wounds of the carotids; the surgeon should explore the wound with an index finger, find the aperture in the vessel, from which he will feel the blood issue with each pulsation, place the tip of his finger on this aperture, enlarge the wound if necessary, apply a ligature on each side of the aperture, and finish by dividing the artery midway between the two ligatures. In the following example, the superior thyroid artery was severed by an incised wound, both ends were ligated, and the bleeding did not recur:—

Private J. H., Co. K, 1st Infantry, aged 27, cut his throat with a razor November 3, 1866. The larynx was opened, and the superior thyroid artery was completely divided. When admitted to the post hospital he was nearly pulseless. Both ends of the divided artery were immediately ligated. The patient did very well, and seemed to improve until the evening of Nov. 5, when he had a choking fit, and died in a few minutes from asphyxia.¹

The hemorrhage from incised wounds involving the arteries of other regions, for instance, the armpit, the groin, the thigh, etc., should be controlled in the same way by the surgeon. He should explore the wound with a finger, feel for the orifice in the wounded vessel from which a stream of blood issues in jets, cover it with the end of his finger, and keep it so covered until he can enlarge the wound, and tie the artery on each side of the aperture. He should also divide the artery midway between the two ligatures, unless this has already been done. Concerning the intercostal, internal mammary, internal epigastric, gluteal, vertebral, and many other different arteries, the reader may consult what has been said concerning them in describing the treatment of punctured wounds of arteries, pp. 567–585.

The *ligatures* to be applied should always be *antiseptic*, and of *animal origin*. Both ends should be cut off near the knot; incised wounds should, as a rule, be closed immediately with interrupted sutures or with strips of adhesive plaster. In all wounds involving arteries, antiseptic dressings only should be applied.

Transfusion is likely to prove useful in many cases of anæmic exhaustion, when it is due to excessive loss of blood from the incised wounds of arteries, and the possible utility of this procedure should not be overlooked in the after-treatment of such cases.

WOUNDS OF VEINS.

Complaints are justly made that this topic receives scant notice in some works on surgery, although the wounds of veins are of frequent occurrence,

¹ Circular No. 3, S. G. O., p. 236.

and although those which involve the large venous trunks must be classed among the most fatal of all accidents. Almost every conceivable wound is attended with the lesion of some vein, however small or large it may be; and wounds of the internal jugular, subclavian, and axillary veins, or of the common iliac, external iliac, and internal iliac veins, are quite as fatal as wounds of the carotid, the subclavian, the axillary, or the iliac arteries, and perhaps even more so. In estimating the gravity of such lesions, it should also be considered that the walls of veins are thin, and their contractile power very feeble; that their capacity, always great, increases with age, so that, when they are opened by wounds, the loss of blood will be greater in the old and debilitated than in the young and strong, while the conveying capacity of the arteries is correspondingly diminished.

The veins are wounded, not only very often, but in various ways: homicidally, suicidally, accidentally, in surgical operations, and in war.

The principal sources of danger in venous wounds are:—

1. Primary hemorrhage.
2. Secondary hemorrhage.
3. Septicæmia.
4. Traumatic phlebitis.
5. The entrance of air into the circulation.

SYMPTOMS OF VENOUS WOUNDS.—A vein is known to be wounded when dark (or so-called venous) blood flows in a rapid and uniform stream from the seat of injury. Sometimes it will be prudent not to decide hastily, especially in cases where the blood issues from a deep wound. Generally, however, the question may easily be determined; but in cases of doubt we may get valuable aid by compressing the main vascular trunks on the cardiac side of the wound. If the hemorrhage be restrained by so doing, we are assured that it is arterial; but if it be increased, we are almost equally assured that it is venous. Still, it should be remembered that in the extremities the blood which flows from the distal aperture of a wounded artery has a dark color, and flows in a steady stream.

The wounds of small veins are less serious than similar injuries of small arteries, because the blood-pressure is less strong, the blood-stream is less swift and powerful, the heart's contractions are less felt, and, consequently, there is less risk from hemorrhage in the former than in the latter. Dr. Otis, the distinguished historiographer of our civil war, observes: "Hemorrhage of consequence from the lesser veins must be a rare event. In a single instance in the reports, attention is directed to bleeding from a gluteal vein."¹ The small veins, when divided, close spontaneously in a few seconds, or their closure may be hastened by elevating the wounded part, or by applying cold or other hæmostatics. When veins no larger than those of the subcutaneous tissue bleed persistently, it is usually because there is some impediment to the flow of blood toward the heart. In a case of this sort which I saw at the battle of Ball's Bluff, the impediment was caused by an extemporized tourniquet, which had been placed around the wounded arm of a soldier by a comrade; on removing the constriction and applying a roller to the arm, the bleeding ceased. In prolapsed hemorrhoids, also, the grip of the sphincter ani often causes a large loss of blood in a few minutes, which can be promptly suppressed by dilating the muscle and returning the tumors into the rectum. So, too, free bleeding from branches of the portal vein is sometimes caused by certain morbid conditions of the liver which obstruct the flow of blood from that vein; and here the causal indication for treatment is to remove

¹ Medical and Surgical History, etc., Second Surgical Volume, p. 338.

the hepatic disorder. The hemorrhage from small veins, when wounded, seldom gives trouble, and can always be controlled by removing the obstruction which causes it. But when large venous trunks, as, for instance, the innominate, the internal jugular, the subclavian, or the axillary, are divided, death follows in a few minutes from the loss of blood, as the cases to be related will abundantly show.

The flow of blood from wounded veins in the neck is remarkably affected by the respiratory movements. During inspiration, when the walls of the thorax are expanded, and when no obstacle is offered to the passage of the blood toward the right side of the heart, the wounded vein remains shrunken or partially collapsed, without shedding a drop of blood; but in expiration, when the thorax becomes contracted, when the great venous channels at the root of the neck become compressed by the lessened diameter of the thorax, and there is a momentary pause in the downward flow of the stream, the blood wells up in the breach as from a fountain.

The wounds of deep veins, even those that are not large, always have a grave importance when the injured vessels are so situated that the blood can flow from their open mouths into one of the great cavities of the body, as, for instance, the cavity of the abdomen, that of the thorax, or that of the cranium; for in this way a fatal hemorrhage may ensue—a hemorrhage, too, over which art has but little control.

The wounds of veins, like the wounds of arteries, may, for purposes of study and description, be advantageously classified as follows:—

1. Incised and punctured wounds.
2. Contused wounds.
3. Lacerated wounds and ruptures.
4. Gunshot wounds.

In incised, in lacerated, and in gunshot wounds, the vessel, as a tube, may be either partially or completely divided. In punctured wounds the division is, of course, always incomplete; and, in contused wounds the vein is not, as a rule, opened until the bruised portion separates as a slough.

When a vein is completely divided, its ends contract, although somewhat less than the ends of a severed artery; they also retract into the sheath. The natural hæmostasis is promoted by these movements, and by the formation of a coagulum around the orifice. But these processes are slow in their operation, very feeble, and practically insufficient, at least in the case of large veins. When, therefore, deep veins of large size are divided and cannot be treated, a fatal result rapidly ensues from the hemorrhage.

When veins of some magnitude are partially divided, the bleeding often gives much trouble. It does not, however, when the injured vessel is superficial, and is located in one of the extremities, because by elevating the limb, and by applying a compress over the wounded part with carefully adjusted pressure by means of adhesive strips or a roller, we can almost always suppress the bleeding, and then, in three or four days, union by adhesion may fairly be expected.

After the hemorrhage is controlled, the wounds of veins, as a rule, heal very quickly. They often unite by the first intention, and heal so perfectly as not to leave any appearance of a scar. The repair of wounds made in veins differs in no essential respect from the same process in arteries. The blood pressure or tension of the circulation in wounded veins, however, is not strong enough to separate the adhesion of the lips or margins while union by the first intention is taking place. Hence, the wounds of veins in one respect heal very differently from the wounds of arteries. While the tubes of the latter are almost invariably obliterated in the human subject, even after punctured wounds, the wounded tunics of a vein can readily be repaired

without at all diminishing its calibre. We all know how seldom the canal of a vein has been obliterated by the operation of venesection; and the same disposition to maintain the permeability and lumen of its canal is witnessed after most wounds in which a vein is partially divided. In a case recorded by Guthrie, where the internal jugular was cut into, the cure at the end of eight days was found to be so complete, that the vessel was not only pervious, but without a mark to indicate where the wound had been.

The following example shows how injured veins heal when ligatured:—

Professor Langenbeck, while removing an epithelial cancer, wounded the internal jugular vein, and tied the cardiac end only, there being no hemorrhage from the distal end. The common carotid artery being involved in the tumor was tied with two threads and divided. When operated on, the man had bronchitis, from which he died on the twelfth day. A *necroscopy* showed the vein completely healed as if by the first intention, without the slightest trace of redness, thickening of its walls, or formation of a clot.

Travers was the first to show that veins, when ligatured or divided, united without any adhesive inflammation. The fact is, the venous tunics when wounded heal more perfectly than almost any other structures in the whole body.

The hemorrhage from wounded veins should be restrained, (1) by raising up or elevating the wounded part; (2) by carefully applying pressure by means of well-adjusted compresses, with adhesive strips or bandages; (3) when these prove inadequate, by applying ligatures, without hesitation, above and below the seat of injury. The ligatures should consist of carbolized catgut, and antiseptic dressings should be applied to the wound. All the measures for restraining hemorrhage from wounded arteries are applicable to wounded veins; and the ligation of veins is as free from special danger as the ligation of arteries.

To ligature a large vein in its continuity, the surgeon should pass around it the blunt end of an eyed probe, or a Mott's aneurism needle, armed with a thread of carbolized catgut, carefully separating the vein from the accompanying artery and nerve, but to no greater extent than is absolutely necessary.

INCISED AND PUNCTURED WOUNDS OF VEINS.—In every act of venesection a punctured or an incised wound of a vein is made. In most amputations the section of large veins is a matter of necessity. In many of the subcutaneous operations for tenotomy or myotomy, the lesser veins are punctured or divided. Sometimes, too, the great venous channels are accidentally opened by surgeons. Wounds of veins thus made generally heal quickly and kindly; and we may well say, therefore, that the incised are the least harmful of all the venous wounds. The incised and punctured forms of venous wounds often occur in the common accidents of life; they are, likewise, frequently made by persons in attempts to destroy their own lives; they are, too, not unfrequently inflicted with the weapons of war and in warfare; and finally, they are sometimes inflicted by persons while committing, or attempting to commit, the crime of murder, and hence they are important in a medico-legal point of view.

The following example comes under the last named-head:—

Mary Dean, a young mulatto girl, was gashed in the left side of her neck, about 10 P. M., June 13, 1880, by Augustus D. Leighton, a jealous lover, with a razor, during an interview, while standing in the street near the basement door of her home. Her aunt, who was looking on from a window above, testified: "I saw him make a sweep with his hand, and Mary vanished into the basement; it was all over in a moment; I found her in the basement, on the floor, all covered with blood, and dead." Another eye-

witness, testified: "Leighton gave a sweep with his right hand; Mary staggered into the basement, and pointing three times up towards her apartments, fell over and died, without saying a word." All the eye-witnesses testified that the blood ran down from her neck in a great stream. At the autopsy, an incised wound, five inches in length and two inches in depth, severing the internal jugular vein but not the carotid artery, was found on the left side of the neck; and there had evidently been but a single stroke of the razor.

It is somewhat remarkable, that, although the internal jugular vein has not unfrequently been opened in incised wounds with a fatal result from the loss of blood, S. W. Gross, on diligent search, could find only four cases on record. This circumstance affords good cause for reporting the above case with some minuteness of detail. Death ensued from the loss of blood in one, or at the utmost, two minutes. Incised wounds dividing the internal jugular vein that have size enough to allow the blood to escape externally without any hindrance, prove fatal quite as speedily as similar wounds of the common carotid artery, if not more so. In accounting for the extreme rapidity with which death ensues, in such cases, the enormous capacity of the internal jugular vein for discharging blood, and its freedom from valves, as well as the anatomical relation which it bears to the great sinuses of the dura mater which empty directly into it, must be considered. Thus, the hemorrhage occurs in a great stream drawn directly from the cranial cavity, whereby cerebral anemia of a fatal character is directly produced with the greatest possible celerity.

The following example, as far as it goes, confirms these views:—

M. Vallée saw a soldier who had been stabbed in the neck, the right jugular vein being almost completely divided. The edges of the wound were retracted, and the vein was empty. Death was almost instantaneous.¹ This example, like the last, vividly illustrates the destructive power of the primary bleeding in such instances.

But, in cases where the internal jugular vein is gashed, if the hemorrhage be restrained by timely compression until the vein can be ligatured above and below the lesion, the patient may be saved, as is shown by the result in the following instance:—

Mr. John Woodman² records the case of a woman whose throat was cut with a razor. A longitudinal wound was found in the left internal jugular vein, a wound therefore at right angles to that in the skin. Owing to the hemorrhage necessitating constant compression, much difficulty was experienced in ligaturing the vein, but it was finally tied above and below the wound. The bleeding came from the distal part of the vessel. The result was successful.

A case is reported in the Medical and Surgical History of our civil war which admirably illustrates the same point:—

Private William McDonald, Co. F, 51st New York Volunteers, received a gunshot fracture of the lower jaw, March 14, 1862. The missile lodged behind the common carotid artery and the internal jugular vein. In cutting down over the ball, in order to extract it, on January 5, 1863, the vein was accidentally wounded. The hemorrhage, however, was inconsiderable, being controlled by pressure, the danger of cutting the vein, and the probability of the accident, having been anticipated and provided for. The ball was extracted with some difficulty. A double ligature was passed around the vein, so as to secure it above and below the aperture. The wound was drawn together by interrupted sutures and adhesive straps. It healed kindly, the ligatures coming away on the ninth day after the operation.³

¹ *Gaz. Médicale*, 1837, p. 267; and *American Journal of the Medical Sciences*, January, 1867, p. 37.

² *British Medical Journal*, October 18, 1873.

³ *Medical and Surgical History*, etc., First Surgical Volume, p. 397.

Thus it is clearly shown what should be done when the internal jugular vein is gashed, whether accidentally by a surgeon in operating on the surrounding parts, or designedly by an assassin; the bleeding must be restrained by compressing the wound, with the fingers if possible, until the vessel is securely tied on each side of the aperture in its walls.

The large veins of the extremities when cut open, whether by accident or by design, should be treated on the same plan if compression is inadequate to suppress the bleeding, as was done by the late Dr. George McClellan in the following instance:—

In extirpating from a gentleman's groin a large fibrous tumor, which was wedged into the external crural ring and the femoral canal, and while detaching it from the femoral vein, he found the saphena interna involved in the substance of the tumor, just as it emptied into the trunk vein. He was obliged to divide it there; and afterward failing to restrain a tremendous gush of black blood by pressure, he pursed up the orifice by a spring tenaculum and Liston's forceps, and had a fine silk thread tied around the margin. This succeeded perfectly in restraining the hemorrhage, and was followed by no inconvenience. He remarks that it was the largest venous orifice he ever saw ligatured, and that it was large enough to admit one of his ring-fingers.¹

Punctured wounds are sometimes accidentally made by surgeons in the walls of large veins, with the points of their scalpels, while removing tumors. In a case which I saw some years ago, where the internal jugular was punctured in this manner while dissecting out a deep-seated tumor of the neck, the margins of the puncture were drawn together and raised up by a Liston's forceps, and a ligature was tied around them on the side of the vessel—that is, a lateral ligature was applied. This proceeding was successful. Nevertheless, it should not be imitated, because of the great risk of secondary hemorrhage which attends it. For example, it is reported on the authority of Nélaton, that Roux tried lateral ligation of the internal jugular in three cases, but that all of them proved fatal from secondary hemorrhage about the sixteenth day.² In such cases the primary bleeding should be controlled if possible by compression, and if, after a fair trial, this is found inadequate, the wounded vein must be ligatured above and below the puncture.

The Army Medical Museum contains a specimen of punctured wound of a large vein. It consists of "a wet preparation of the left femoral vein pierced by a darning-needle. Private B. A., 'A,' 5th Iowa, 40; a conoidal ball passed through Scarpa's triangle without directly injuring the bloodvessels, Vicksburg, 19th May; admitted to hospital with wound in a sloughing condition, Memphis, 27th; hemorrhage checked by compression, 31st of May; wound opened and needle extracted from the sheath at 2 P. M.; artery ligated for secondary hemorrhage at 8 P. M.; died at 11 P. M., 1st June, 1863."³

The veins in the extremities are often punctured by the fragments in cases where the long bones are fractured. In such cases, considerable tumefactions not unfrequently arise from the extravasations of venous blood, but, as a rule, they speedily subside under the combined influence of quietude and moderate compression. The large veins in the neck, etc., are sometimes pierced in a fatal manner, in gunshot wounds, by the splinters of bone that are broken off by musket-balls. For instance, Stromeier, in 1849, had a case of gunshot fracture of the lower jaw, in which fragments of the bone were driven deep into the throat. The man "died suddenly on the fourth day, in the presence of his attending physician, a thick stream of dark blood issuing from his

¹ Principles and Practice of Surgery, pp. 194, 195. Foot-note.

² American Journal of the Medical Sciences, April, 1867, p. 327.

³ See Catalogue, A. M. M., p. 472, Spec. 2020.

mouth." The *autopsy* showed an opening in the internal jugular vein, made by a splinter of bone, which still remained in it.¹ As soon as the mechanical obstacle became loosened by suppuration, hemorrhage ensued.

Large veins are sometimes punctured by the minute bird-shot or squirrel-shot of sportsmen, as happened in a case already related on page 565, that occurred in the practice of Professor Gross, where the right internal jugular vein was penetrated by a squirrel-shot, and the venous wound healed in a noteworthy manner, without the aid of a blood-clot or the occurrence of inflammation—healed in fact by the first intention—and the shot itself became encysted, by the same process, in the wall of the vein at a point opposite to the place of entrance. The patient died on the fourteenth day after the accident, from protracted epileptic convulsions, and the autopsy revealed what has just been described.² The subclavian artery also was punctured. The case is of some importance, because it shows the way in which venous wounds may heal, and that the venous tunics may sustain a severe injury without renting it.

A large vein is sometimes accidentally punctured or transfixed by an artery-needle in performing the Hunterian operation for aneurism. Two fatal examples of this sort, in which the internal jugular was pierced through and through, are presented by Dr. S. W. Gross in a most excellent article on "Wounds of the Internal Jugular Vein."³ The transfixion of the vein escaped notice in both instances, and the ligature passing through the vein acted as a seton after the operation. Hence, there ensued ulcerative inflammation in the vein-wall, and the train of phenomena usually ascribed to diffuse or suppurative phlebitis, with death from pyæmia. Indeed, it would be hard to plan an experiment more likely to produce such results than the establishment of a seton in this manner in a large venous trunk extending across its channel. There are also on record some fatal cases in which the femoral vein was pierced in like manner, while operating on Hunter's plan for popliteal aneurism. It is, therefore, of great importance that this mishap should be avoided, and, in case it does occur, that it should immediately be detected. In such cases the ligature must be withdrawn, and reapplied at another point. The bleeding will generally cease on tightening the ligature, this cutting off the blood-supply that otherwise would go to the distal part of the limb, and flow back toward the heart through the punctured vein.

CONTUSED WOUNDS OF VEINS.—The tunics of veins, like the tunics of arteries, are sometimes bruised by the impact of musket-balls and other missiles in gunshot wounds. When large arteries are contused in this manner, the accompanying veins, likewise, are often found to be contused. For example, in one of Mr. Guthrie's cases, already mentioned in the section on Contused Wounds of Arteries, the walls of the femoral vein were bruised by a musket-ball as well as the walls of the artery, and the canal of the vein was "filled by a coagulum, and impassable" at the bruised part. The case of P. Ryan, related in the same section, in which a bullet had grazed, but not opened, the sheath of the femoral vessels, and bruised the femoral artery, affords another illustration. "The vein, however, was not only also slightly contracted, but its internal surface was inflamed and filled with partially organized lymph, as far up as the entrance of the deep iliac vein, and downwards for about two inches from the wound. Its course was thus entirely sealed, but nothing like pus could be found in the femoral or iliac veins, nor in the system anywhere."⁴

¹ American Journal of the Medical Sciences, January, 1867, p. 39.

² Ibid., January, 1867, pp. 41, 42.

³ Ibid., January, 1867, pp. 31, 32.

⁴ Surgical History of the Crimean War, vol. ii. p. 343.

In both cases the inflammation was formative in character, and there resulted contraction of the bruised part of the vein, and obliteration of its canal.

But the contused wounds of veins which are caused by musket-balls and other like missiles, not unfrequently give rise to secondary hemorrhage. The bruised part of the vein separates as a slough, the canal of the injured vein is opened, and an effusion of blood into the wound, or a hemorrhage, takes place. The Army Medical Museum contains several specimens which illustrate this accident:—

One of them is “a wet preparation of a portion of the right internal jugular vein, after secondary hemorrhage from gunshot. The specimen shows the point of sloughing, and is occupied by a coagulum two inches below the orifice. Private S. W. S., ‘B.’ 1st N. Y. Dragoons, 23; ball entered two inches below and to the right of the superior angle of the scapula, passed through the neck and fractured the inferior maxilla. Spottsylvania C. H., Va., 8th May; admitted to hospital, Alexandria, Va., 24th; secondary hemorrhage, arrested by persulphate of iron, 27th May, 1864; date of death not reported.”¹

Another illustration of this accident is “a wet preparation of the upper portion of the femoral vein, showing the point of sloughing after gunshot. The orifice is nearly opposite the mouth of the profunda.” Private M. H., aged 21, was the patient. He was wounded and admitted to hospital April 1, 1863. Venous hemorrhage occurred on the 10th, 11th, and 13th; on the 15th he died. In both instances the loss of blood appears to have been the cause of death.²

The following case belongs to the same category:—

Private M. A. R., Co. E, 46th Ohio Vols., wounded at Dallas May 27 or 28, 1864; admitted to hospital on the 28th. A ball entered the right side of the face about the middle of the buccinator muscle, fractured the inferior maxilla, passed downward into the neck on the same side, and, lodging, could not be felt. May 30—He felt well; appetite and pulse good, but he could swallow liquid food only. He continued to do well until June 7 and 8, when he lost a great deal of blood from the wound, and became much reduced thereby. On the 27th there was some hemorrhage at seven A. M., which was arrested by compression. At nine o'clock he had a convulsion, and died. At the *autopsy*, the internal jugular vein was found opened for about four inches, and the tissues on the same or right side of the neck were infiltrated with pus. The missile had also fractured the transverse processes of the third and fourth cervical vertebrae, and had passed into the chest.

In this case the missile was deflected downward into the neck by striking the lower jaw. Thus, the internal jugular vein was grazed and bruised. Some ten or eleven days after the casualty, and when the slough separated, the internal jugular was opened, and profuse hemorrhage from the wound took place. The bleeding was suppressed, but after a time it recurred, and the man died, having syncopal convulsions (*convulsio syncopalis*) due to the loss of blood. Were it desirable, additional examples could readily be adduced.

Treatment.—The principal indications to be fulfilled in the management of contused wounds affecting veins are: (1) To prevent the occurrence of ulcerative phlebitis and secondary hemorrhage; (2) to prevent the absorption of septic matter and the occurrence of septicaemia or pyaemia. Both of these indications are best accomplished by the use of antiseptic dressings and thorough drainage in such wounds; for, in this way, the retention and putrefaction of purulent matter are avoided, and these two sources of danger are eliminated from the case. Should, however, secondary hemorrhage occur, it must be restrained without delay by compression (digital or otherwise) until the bleeding vein can be laid bare, and securely tied above and below the aperture in its walls with ligatures of carbolized catgut. In cases where

¹ Catalogue, A. M. M., p. 470, Specimen 2441.

² Ibid., p. 471, Specimen 1093

large venous trunks, such as the internal jugular, or the axillary, or the common femoral, are opened in this manner, promptitude in getting complete control of the hemorrhage is a matter of the first importance; and, therefore, no time should be lost in experimenting with the persulphate or the perchloride of iron, or other astringent substances.

LACERATED WOUNDS AND RUPTURES OF VEINS.—The walls of veins are much thinner and less strong than the walls of arteries; hence, the subcutaneous veins are much more liable to be ruptured by blows than the corresponding arteries. Contusions of the soft parts are very often attended with the laceration or rupture of underlying veins, giving rise to dark discolorations or ecchymoses, and, sometimes, to large sanguinolent collections, which remain liquid for a long time. These bloody tumefactions, or *hæmatomata*, should never be opened by the surgeon unless they suppurate, that is, terminate in abscess, or, having become very chronic, cause annoyance by their bulk. While they are still recent, time and the employment of stimulating lotions, in order to hasten absorption, constitute the proper method of cure.

Large veins are sometimes torn completely across in open lacerated wounds:—

A case of the kind occurred some years ago in the person of a gentleman, under the late Dr. George McClellan's care. "His right groin was caught by a large, blunt, iron hook, in a horse-mill, and he was dragged rapidly round the area by it, until a monstrous rent was torn across, just below Poupart's ligament, laying bare the femoral vessels and nerves. The artery was completely denuded, and the vein torn across. A prodigious venous hemorrhage ensued." The artery was taken up, although it did not bleed at the time. The hemorrhage from the vein was restrained by filling the wound with graduated compresses, and binding them down with a thick bandage. "The result was, that the enormous wound finally healed, and the gentleman eventually got well, although in the mean while the leg mortified and was amputated just below the knee."¹

Dr. McClellan's remarks on this case are so pertinent that I will quote them: "Now it is an interesting point to decide whether the ligation around the main artery, which I supposed to be unnecessary and would have opposed, had I been consulted respecting it before the operation, was the cause of the mortification, or whether, as was inferred by some, it was not rather calculated to prevent that unfortunate occurrence. The latter class of my friends considered that the destruction of the great vein at the groin would have caused too great a congestion of venous blood in the parts below, unless the corresponding artery had also been obstructed by the ligation. But other veins, as well as arteries, might have become dilated in the meanwhile, as indeed they must have done to some extent, because the vitality of the whole knee and parts above was preserved."

The recovery of the patient, in this case, shows that the ligation of the artery was good practice; without such a ligation of the femoral artery, the bleeding from the severed femoral vein would not have been controlled by compression applied in the wound. The restraining effect of tying the femoral artery upon hemorrhage from the femoral vein is well shown by one of Professor Agnew's operations for popliteal aneurism, wherein he wounded the femoral vein in passing the thread around the artery; "the venous hemorrhage, which for a time was profuse, immediately ceased on tightening the ligation, and did not afterward return."² It is not difficult to conceive how ligaturing the main artery of a limb aids in suppressing hemorrhage from the corresponding vein, for it greatly reduces the supply of blood to be returned by the wounded vein, and arrests the *vis a tergo* impulse which otherwise would be imparted by the arterial contractions to the circula-

¹ Op. cit., p. 171. Foot-note.

² Op. cit., vol. i., p. 516.

tion in the wounded vein. The femoral artery was ligatured, in the case related above, about the year 1842, almost twenty years in advance of the famous advice of Langenbeck to the same effect, for suppressing hemorrhage from wounds involving large veins.

The axillary vein, in rare instances, has been ruptured during attempts to reduce old dislocations of the shoulder-joint:—

Froriep reported the first case: A scrofulous subject, aged 26, was found, twenty days after the accident, to have sustained a dislocation of the shoulder. At a second attempt at replacement, two distinct sounds were heard, and the dislocation became reduced; but, at the same moment, an axillary swelling appeared. The swelling rapidly increased. The patient fainted twice, vomited, went to stool, and expired one hour and a half after the reduction. The axillary cavity was found full of blood, and the axillary vein broken almost entirely across. Its coats were very weak above and below the rupture.¹ A second case belonging to the same category happened to Flaubert, in 1827. Some years ago, the late Mr. Price² was reducing, at the Great Northern Hospital, an old dislocation at the shoulder of an aged female, when the axillary vein, as was subsequently ascertained, was torn across, the patient dying on the following day. The artery was not ruptured. This made the *third* case. In 1863, a *fourth* case occurred to Hailey. In 1873, Professor Agnew observed and recorded a *fifth* case. A woman, aged 60, had a dislocated right shoulder of six weeks' standing. Steady and persevering extension was exerted for several minutes while an assistant's hand was held in the axilla to guide the head of the bone toward the glenoid cavity. A swelling suddenly appeared in the right pectoral region, distending in an instant the entire breast, rendering it exceedingly prominent, and forming a firm but fluctuating tumor. The patient instantly became cold and collapsed; respiration ceased, and the pulse could not be felt. The subclavian artery was compressed, the tongue drawn forward, and cold douches, ammonia, artificial respiration, etc., tried. The patient rallied, and on relaxing the pressure it was found that the radial pulse on that side was just as strong as on the other. The tumor was not tense and distended, and did not seem filling with any force. Compresses were firmly applied, with warmth externally and stimulants internally. The swelling slowly extended backward, but did not become more tense. In ten days she was discharged.³

Rupture of the axillary vein is more deadly than even rupture of the axillary artery. Of the five examples, Dr. Agnew's was the only one which ended in recovery. I have related it with considerable minuteness, in order to illustrate the symptoms and treatment of this accident. In some rare instances the axillary artery and vein are simultaneously ruptured during efforts to reduce old dislocations of the shoulder-joint. The chief danger in all these cases is that which arises from the subtegumentary bleeding; and unless adequate measures to restrain it are instantly taken, the patient will succumb to it. These measures are: (1) To compress the subclavian artery against the first rib; (2) to place an extemporized tourniquet, for instance, a handkerchief, around the upper end of the arm; (3) to confine the arm to the side of the chest with a firm bandage. In cases where the artery and vein are both ruptured, should the extravasation of blood happily be restrained from the first, and should the patient happily escape the perils which are denoted by the symptoms of shock and collapse, primary amputation of the arm at the shoulder-joint should be performed.

The great venous trunks may be ruptured in railway accidents, as happened in the following instance where the subclavian was involved:—

Valentine K., commissary department, was caught between the buffers of two railway cars July 20, 1863. The humerus, clavicle, and scapula were fractured, and the neigh-

¹ Malgaigne, *Traité des Fractures*, etc., t. ii. p. 151.

² St. Bartholomew's Hospital Reports, vol. ii. pp. 107, 108.

³ Philadelphia Medical Times, Aug. 16, 1873.

boring soft parts were pulpified, although the skin was not broken. The arm sphacelated, and the man died on the 23d. The subclavian artery was obliterated where it leaves the first rib. The subclavian vein was torn open, and thus the extravasated blood with which the injured parts were distended had been supplied.¹

The large veins sometimes get torn open when their coats are weakened by disease, as occurred in the following case where the internal jugular was ruptured during the performance of an operation for epithelioma of the neck:—

“The tumor was removed in September, 1876, the external jugular vein being tied. In March, 1878, the patient returned, and had the growth removed a second time. During the operation the internal jugular vein gave way, its walls being involved and softened, and was tied above and below. The patient made a good recovery, and in July, 1880, was known to be alive and well.”²

When this accident occurs, the vein must be tied above and below without delay, as was done in this case; and when the internal jugular is the injured vein, it certainly is not necessary to tie the common carotid artery, as proposed by Langenbeck, unless its tunics are also involved in the disease for which the operation of removal is performed.

Spontaneous rupture of the internal jugular vein, with the formation of a cervical thrombus, etc., may occur, as happened in the following instance reported by Nélaton:—

The thrombus caused great swelling of the neck. It was opened to relieve the extreme dyspnoea which it produced by pressing on the air-passages, under the supposition that it was an abscess. The hemorrhage that followed was so copious that the incision was prolonged in order to bring into view its source, which was found to be an oval opening into the internal jugular vein. This Nélaton plugged with a cylinder of agaric, and the bleeding did not return. It came on during scarlatina.³

Moreover, the tunics of the internal jugular vein may be so much weakened by an abscess of a contiguous gland, that they will give way, and allow a thrombus of the neck to ensue; and if the issue of blood from the aperture in the vein cannot be controlled by the application of agaric and pressure, the vein itself must be ligated above and below the aperture with carbolized catgut. In those instances where the aperture in the wall of the vein is small, as it appears to have been in the case reported by Nélaton, the application of agaric with compression will probably succeed in restraining the hemorrhage.

GUNSHOT WOUNDS OF VEINS.—The nature and importance of the subject can be best shown by presenting brief abstracts of some examples:—

A soldier, aged 24,⁴ was wounded May 22, 1863, and entered a general hospital on the 27th. The ball entered midway between the left trochanter major and the apex of the coccyx, passed obliquely through the lower part of the pelvis and upper part of the right thigh, and emerged in the right femoral region, one inch below Poupart's ligament. Patient stated that very profuse hemorrhage occurred immediately after the reception of the wound; and, at every considerable motion of the patient, blood escaped from the femoral orifice of the wound, despite the pressure of compresses. Urine escaped from both orifices of the wound. On the 30th, slight diarrhoea, accompanied by deep jaundice, appeared. On June 4, the patient expired. *Necroscopy* revealed that the prostate gland, at its junction with the bladder, was cut away; that there was

¹ Medical and Surgical History of the War, First Surgical Volume, p. 527.

² Medico-Chirurgical Transactions, vol. lxiii. (1880); also American Journal of the Medical Sciences, April, 1881, pp. 481, 482.

³ Journ. de Méd. et de Chirurg., t. xxii., November, 1861, p. 499.

⁴ Med. and Surg. Hist. of the War of the Rebellion, Second Surg. Vol., pp. 304, 339.

not much infiltration of urine; that the right ramus of the os pubis was shattered into fragments; and that the right femoral vein was widely opened by the wound. The specimen is preserved in the Army Medical Museum, and has been already figured in this work in the article on Gunshot Wounds. (See Fig. 315, *supra*, p. 211.) The opening in the vessel is very large.

In this case death was due to anæmic exhaustion, the result of numerous small hemorrhages. The original orifice in the vein probably became enlarged by the separation of a slough. At the outset it appears to have been but small.

In the following example the femoral vein was cut almost in two by a pistol-ball. Death ensued from hemorrhage in about two hours, although what was thought to be efficient compression was applied to the wound:—

Private John Eberhardt, Co. A, 17th Infantry, aged 21, was shot on October 29, 1868, at Belton, Texas, by a ball from a Colt's navy-revolver, which entered the right thigh three inches below Poupart's ligament, internal to the sartorius muscle, passed backward and slightly upward, nearly severing the femoral vein, grazed the femur, internally, at the junction of the shaft and neck, passed through the gluteal muscles, and lodged under the cuticle opposite the great ischiatic notch. The patient, unaware of his wound, continued walking or running until he fell, faint from the loss of blood. He was seen some fifteen or twenty minutes after the occurrence; the missile was extracted, an efficient compress was placed over the wound, and stimulants were administered. But he never reacted. He died in about two hours from hemorrhage.¹

This example supports my view, that in cases when the femoral vein is severed, or almost severed, the hemorrhage cannot be restrained by compression, unless by ligature of the femoral artery the supply of blood to the distal part of the limb is cut off at the same time. In cases where it is not advisable to tie the artery, the wounded vein should be ligatured without any delay above and below the aperture; or else primary amputation should be performed.

In the following case the femoral vein was injured together with the accompanying nerve. Death ensued in four days from the loss of blood and mortification of the leg:—

A citizen, aged 17, was wounded by Indians, at night, while sitting at a camp-fire, just outside the stockade of Fort Philip Kearney, on November 2, 1866. The missiles were supposed to be slugs from a shot-gun. Two entered the inner side of the right thigh, in the middle third, and passed through just behind the femur. Two others passed through the calf of the right leg; another comminuted the second joint of the right index finger. *Liquor ferri persulphat.* was used to arrest the hemorrhage, which was venous, and simple dressings were applied. The patient died on the 6th, from shock, venous hemorrhage, and gangrene of the leg. An autopsy revealed laceration of the femoral nerve and injury of the femoral vein.²

In a case reported on the same page, which I have already mentioned in another place, where the femoral artery and vein were both severed by a round pistol-ball, death occurred in a few minutes, from hemorrhage. In another case, reported on page 85, of the same circular, where the femoral artery and vein were severed in a shot wound, the man bled to death, notwithstanding the apparently prompt application of a tourniquet. In such cases as these two, however, the hemorrhage is mainly arterial. For injuries like those sustained by the citizen above-mentioned, namely, laceration of the femoral vein with laceration of a great nerve and shot-perforations of the calf of same leg, primary amputation should always be performed.

There is a case of gunshot wound involving the right femoral vein, recorded in the Medical and Surgical History of the War,³ in which life was prolonged

¹ Circular No. 3, S. G. O., p. 86.
Second Surgical Volume, p. 339.

² *Ibid.*, p. 73.

for eighteen days, although no particular effort appears to have been made to suppress the bleeding:—

A soldier was wounded October 5, 1864, by a conoidal ball, which entered the left side of the scrotum above the testicle, passed almost transversely to the right, and emerged anterior to the right trochanter major. The discharge from the wound was sanio-purulent, and frequently attended with venous hemorrhage, the latter becoming more copious daily. On the 23d the man died. *Autopsy*—The track of the missile was extensively ulcerated; the femoral vein was severed, and contained purulent matter. The spermatic cord was also severed. The shot-lesion of the femoral vein, in this case, was probably a contusion at the outset; the bruised portion of the vein-wall sloughed, and, as the slough separated, the canal of the vein was opened daily more and more. Thus the bleeding increased from day to day, until death ensued from the frequently-repeated hemorrhages. Perhaps, a patient similarly wounded might be saved by the use of antiseptic dressings and drainage-tubes in the track of the missile, together with deligation of the vein above and below the aperture, performed when the first bleeding appeared; and, with a view to deligation, it would be good practice in similar cases to explore the wound, enlarging it if necessary, in order to lay bare the source of the bleeding.

Another large vein, which is not unfrequently opened by small-arm missiles and portions of shells, is the *internal jugular*. The Army Medical Museum contains a specimen in point:—

“A wet preparation of a portion of the right jugular vein, wounded by a round bullet from a spherical case (shot). A part of the parietes of the vein has been carried away, and in the posterior portion an orifice is seen, through which the contributor considers the missile passed. Private H. O., ‘A,’ 5th U. S. Artillery, Suffolk, Va., 15th April; died 19th April, 1863.” In such cases, death ensues from hemorrhage, unless the vein is promptly ligatured above and below the lesion.

The next two examples will serve to show how insufficient styptics, and compression, and cold applications, and position are to restrain the hemorrhage from wounded jugular veins:—

A soldier was struck, July 18, 1863, by a piece of a shell, in the root of his neck, tearing open the branches of the thyroid axis and the internal jugular vein. Styptics and compresses, etc., were applied, because it was decided that to operate for ligation would hasten death on account of hemorrhage. He died on the 27th.² In a case like this the surgeon would be justified in assuming many risks rather than abandon the patient to otherwise almost inevitable death.

Again; Sergeant J. W. J., Jr., Co. D, 28th Mississippi Cavalry (Confederate), was wounded and captured, April 10, 1863. A conoidal ball entered his neck opposite the thyroid cartilage, at the inner border of the left sterno-mastoid muscle, and emerged about an inch and a half to the left of the lower cervical vertebræ. He lost, in the course of three hours, perhaps two quarts of blood, when the hemorrhage ceased. On the second day he was taken with severe chills, which recurred at the rate of two or three a day, followed by high febrile reaction. Death resulted on the 16th, that is, six days after the casualty. The *autopsy* showed the internal jugular vein completely divided; the surrounding tissues were extensively infiltrated with pus and blood; and the divided extremities of the vein contained a large amount of pus.³ Had both ends of the severed vein been securely tied, without delay, in this case, not only would all bleeding have been suppressed, but also the entrance of purulent matter into the open mouths of the vein would have been prevented; and the patient would have had some chance of recovery. At least, the risk of death from purulent absorption would have been very much diminished by such a proceeding.

¹ Catalogue A. M. M., p. 470. Specimen 1055.

² Medical and Surgical History, etc., First Surg. Vol., p. 411.

³ Ibid., pp. 411, 412.

S. Cooper has published a noteworthy instance of an oblique gunshot wound opening the internal jugular vein, in which death ensued from the pressure that was exerted on the air-passages by the subtegumentary extravasation of blood:—

A soldier was shot, the ball entering behind the mastoid process and passing downward and forward toward the sternum. The internal jugular was divided; the man lived more than an hour, but was suffocated by the pressure on the trachea of a large mass of extravasated blood which could not escape outwardly.¹

Breaches in the walls of the internal jugular vein made by gunshot missiles sometimes heal spontaneously. There are at least two examples on record:—

Dr. Stromeyer saw, at Colding, a Schleswig-Holstein soldier who had been shot in the right side of the lower jaw, and across the neck under the tongue, the ball lodging and remaining unextracted. There had been no hemorrhage. The patient died, at the end of three weeks, from pyæmia. At the *autopsy* an abscess was found behind the left sterno-cleido-mastoid muscle, in which the flattened bullet lay near the vertebral column. "The internal jugular vein had been torn to the extent of five lines on its antero-outer aspect; but the rent was completely healed, as the coats of the vein had applied themselves to it from behind, and were united thereto, so that the cylinder of the vessel was diminished one-half."²

Dr. Schwarz observed the other case: A rifle-ball, entering the mouth, shattered the lower jaw, tore open the internal jugular vein, and, lodging at the aperture, restrained the bleeding. Suppuration ensued, with death from pyæmia. An *autopsy* showed a completely healed rent in the outer wall of the vein, the cylinder of which was slightly diminished, but free. At the cicatrix, the coats of the vein were thickened by plastic deposits, and a very adherent, semi-organized layer of lymph coated the lining membrane. The small veins contiguous to the abscess, in which lay the ball, were filled with broken-down coagula.³

The *prognosis* in gunshot wounds that involve the internal jugular vein is very bad. Dr. S. W. Gross was unable to find on record a single case of recovery from this lesion. "On the contrary, all the cases have proved fatal; 62.5 per cent. from secondary hemorrhage; 25 per cent. from pyæmia, and 12.5 per cent. from primary hemorrhage."⁴ Recovery from gunshot lesions of the internal jugular must be very rare; for an extended search has failed to furnish me with even one undoubted case of such a recovery. The First Surgical Volume of the History of the War contains, however, the abstracts of two successful cases of gunshot wound of the neck, in each of which it is probable that the internal jugular was injured.⁵

Shot wounds of the *axillary vein* were occasionally noted during our late civil war; but no example was reported of a shot-wound of the *subclavian vein* that came under treatment. The case reported by Mr. Blenkins,⁶ where a ball passed between the right subclavian artery and vein, wounding the latter and causing fatal phlebitis, remains the solitary recorded instance. But, as Mr. Fraser observes, the exemption is ideal rather than real, for probably a large proportion of those killed in battle die from torn blood-vessels.

WOUNDS OF THE SINUSES OF THE DURA MATER.—Brief mention must be made of the traumatic lesions which have been observed in the great venous

¹ First Lines of the Practice of Surgery, vol. i. p. 529. New York, 1822.

² American Journal of the Medical Sciences, January, 1867, p. 40.

³ Ibid., p. 40.

⁴ American Journal of the Medical Sciences, January, 1867, p. 36.

⁵ Op. cit., pp. 412, 422.

⁶ Fraser, Treatise on Penetrating Wounds of the Chest, p. 13.

canals of the encephalon. In the following example, the left petrosal sinus was lacerated by a fracture of the skull; death from cerebral compression speedily ensued:—

A young lady (Emma Leiding) in Brooklyn, on October 4, jumped off from an Atlantic Street horse-car, which was running away down hill, the brakes having failed. She alighted on her feet, but, in her fright, fell backward striking upon her head. She was immediately picked up insensible, having a scalp-wound on the back part of the head, and soon afterwards died without recovering consciousness. *Autopsy*, Oct. 5.—The only mark of violence found externally was a contused and lacerated wound of the scalp on the posterior part of the head. On opening the skull, a large quantity of uncoagulated (or liquid) blood was discovered in the cranial cavity. On removing the brain, the base of the skull was found fractured on the left side; the left petrosal sinus was ruptured, which accounted for the hemorrhage. No other lesions were present. Thus, the cause of death was cerebral compression, the result of extravasation of blood from a lacerated petrosal sinus. Moreover, extravasations of blood from wounds of this vessel are apt to prove quickly fatal, *first*, because they are rapid and copious, and *secondly*, because they directly compress the medulla oblongata. In such cases there is no return of consciousness. The insensibility of cerebral concussion is succeeded by that of cerebral compression, without any appreciable interval. Such cases are not remediable.¹

Other cases, however, are remediable. For instance, Guthrie² reports the following case:—

A dragon fell from his horse, in consequence of a wound in the trunk, on to the top of his head. Coma supervened. A swelling of the scalp was noticed at the vertex, where he had struck; this, on being incised, showed a separation of the edges of the sagittal suture, from which some blood flowed. Two crowns of a trephine were applied on the twelfth day, in order to obtain a free discharge of some blood which had been extravasated from a wound in the superior longitudinal sinus, after which the symptoms subsided, and the man gradually recovered.

M. Mouton mentions a similar instance in which he was called to see a man eleven days after a fall. The patient was insensible and almost dying, in consequence of an extravasation of blood from the superior longitudinal sinus, wounded by a separation of the sagittal suture. Trephining gave vent to the extravasated blood, and the threatening symptoms immediately ceased.³

Wounds of the longitudinal or lateral sinuses are not dangerous, provided the external opening is large enough to allow the blood to escape freely. But when the blood cannot escape in this way, such wounds are extremely dangerous from the attendant compression of the brain.

M. Lassus presented two cases in which the superior longitudinal sinus was opened by punctured fractures of the parietal bones at the sagittal suture. In each case a trephine was applied, the fragments or splinters of bone were pulled out of the sinus into which they had been driven, the bleeding was stopped by applying some dry lint to the rent in the sinus, and the patient made a good recovery.⁴

M. Gagnière has reported a case in which the superior longitudinal sinus was wounded by a blow on the top of the head with a dung-fork. He enlarged the opening in the scalp by a cruciform incision, and extracted the fracture-splinters; and he then perceived a clot of blood which had formed in the opening of the sinus, which had been made by the fork. The dressing, which was made in the manner usual after trephining, was moistened with spiritus balsamicus, a powerful antiseptic; no severe symptoms followed, and the wound was quite healed by the end of three months.⁵

¹ Mr. Prescott Hewett records a most extensive extravasation of blood between the bone and the dura mater, which proceeded from a rupture of the right lateral sinus, just as it turns under the petrous portion of the temporal bone, in a case of fracture. (Trans. Patholog. Soc. of London, vol. iii. p. 229.)

² Commentaries on Surgery, etc., p. 349, Am. ed.

³ Memoirs of the Royal Acad. of Surgery of France, Sydenham Society's Translation, p. 8.

⁴ Ibid., pp. 66, 67.

⁵ Ibid., p. 69.

Percival Pott, in a hopeless case where the superior longitudinal sinus was laid bare by a compound fracture of the skull, for a space at least two inches in length, wishing to abstract blood, made an opening with a lancet into the sinus, and suffered the blood to run off until the countenance, which was flushed, became pale. He then put a bit of lint on the orifice, and by pressing thereon lightly with a finger, easily stopped the bleeding. This venesection caused no trouble. The patient, however, died on the twelfth day afterward, from a cerebro-meningeal abscess, due to the original injury.¹

In some sabre wounds, which divide the skull across the sagittal suture, the longitudinal sinus has occasionally been opened and bled profusely, but without inducing fatal consequences. Hennen has seen this sinus opened by splinters, but never saw anything approaching to dangerous hemorrhage from it.²

In the case of a child, aged 3 years, the great longitudinal sinus was opened by a punctured fracture of the skull, made with the sharp point of a pickaxe; much venous hemorrhage ensued from a small wound over the sagittal suture; a probe inserted into this wound passed down to the corpus callosum. A pad of lint was applied to the wound, and an ice-bag was kept on the head; the patient made satisfactory progress to recovery.³

Foreign bodies lodged in a sinus of the dura mater do not readily excite intra-venous inflammation. For example, in December, 1868, one of the demonstrators of anatomy in the Calcutta Medical College met with a calvaria (now in the College Museum) in which an iron headless nail, about an inch long, had penetrated the frontal bone on the mesial line, and, passing completely through the longitudinal sinus, had divided the layers of the falx cerebri, between which its point is visible; consequently its shaft, which was not corroded, stood in the mid-current of blood in the sinus, and seems latterly not to have caused any inconvenience. The edges of the hole in the frontal bone, which the butt-end of the nail still occupies, are so rounded that it looks like an arterial foramen, and there is not the slightest trace of inflammatory change within.⁴

Lastly, I will state a few conclusions derived from the foregoing: (1) Wounds of the sinuses of the dura mater do not possess any peculiar elements of danger. (2) Hemorrhage from wounds of these sinuses is not dangerous unless the extravasation is retained within the skull; in which case it becomes very dangerous because of the compression of the brain that ensues. For its relief the operation of trephining should, if possible, be performed. (3) External bleeding from wounds of these sinuses can generally be restrained, without much trouble, by applying dry lint with slight or very moderate pressure. But, under no circumstances, should the persulphate or perchloride of iron be put in such wounds, because of the possibility of its getting into the injured sinus. (4) Antiseptic dressings should be applied, together with the ice-bag if there be any tendency to meningeal inflammation or to a cerebral abscess.

SEPTICÆMIA FROM WOUNDS OF VEINS.—A wounded vein or sinus of the dura mater, whose open mouth is surrounded by, or bathed in, purulent fluid, may afford an avenue for the introduction of septic matter into the circulation, which will infect the blood and the whole system, that is, produce septicæmia. Professor Agnew has seen a trifling wound of the cephalic vein, below the line of the deltoid, prove fatal from this cause.⁵ The writer has seen a lesion of the same vein, made in opening an abscess of the arm, prove

¹ Chirurgical Works, vol. i. p. 134, Am. ed.

² Principles of Military Surgery, p. 231, Am. ed.

³ Lancet, August 22, 1874, p. 270.

⁴ British and Foreign Medico-Chirurgical Review, October, 1871, p. 353.

⁵ Op. cit., vol. i. p. 516.

fatal in the same way. The extension of morbid processes from unhealthy wounds into the severed veins, through their open mouths, has often been observed. For instance, Dr. Macleod, in his *Notes on the Surgery of the Crimean war*, states: "We had many most beautiful examples, post-mortem, of veins leading from the stump remaining round, patulous, and filled with pus, and sometimes reddened in their interior. It was not uncommon to trace the pus-filled vein from the thigh to the vena cava."¹ There is no doubt that a septicæmic thrombosis is readily started in severed veins whose open ends lie uncovered in unhealthy suppurating wounds; and that this septicæmic thrombosis is much inclined to spread upward toward the right auricle. I have several times found such thromboses on examining, post-mortem, the bodies of those dead from gunshot fractures of the thigh and similar injuries. Hence, I think that Dr. Macleod, with much propriety, raises the question whether it would not be justifiable to ligature the chief veins of amputated limbs, at the time of the operation, especially, if the so-called purulent absorption should be an accident of common occurrence. He states that "numerous cases are on record in which the ligature of veins has not only not been followed by evil results, but has absolutely been the apparent cause of preventing inflammation and pus-absorption." This is particularly well illustrated in a case related by Mr. Johnston, of St. George's Hospital, in the journals of 1857. In that case, those vessels which had been tied were free from both inflammation and pus, while those not included in ligatures were full of pus, and "much inflamed." I do not doubt that ligatures applied to veins, in wounds likely to become the seat of unhealthy suppuration, may prevent the introduction of septic matter into the blood, as well as the occurrence of septicæmic thrombosis, and septicæmia itself. My views fully accord with Velpeau's, concerning the advisability of oftentimes securing wounded veins with ligatures, when he in substance says: "The dangers of ligation, which so many surgeons have insisted on for half a century, are shown to be farthest from the truth, and I should not be surprised to find that it would prove more advantageous to close veins immediately with ligatures, than to leave them open at the bottom of wounds."² Mr. Liston, too, feared the consequences much more when the ends of divided veins remained open in suppurating wounds, than when they had been closed by applying ligatures.

To prevent the occurrence of septicæmia or pyæmia in cases where veins of importance are wounded, it is advisable: (1) To secure the opened veins with carbolized catgut ligatures applied on the cardiac, as well as on the distal, side of the wound. (2) To treat the wound itself on the antiseptic plan. (3) To prevent any collections of purulent matter from forming or burrowing around the injured veins, by thorough drainage, and by frequent renewals of the dressings. In cases where the skull is injured, it is, likewise, very important to prevent any collections of matter from forming on the sinuses of the dura mater, by early incisions, by changing the dressings at short intervals, and by securing as good a drainage of the wound as possible.

LIGATION OF VEINS.—When a delicate, strong, and well-waxed silk thread is drawn as tightly as possible around a large vein, its tunics become thrown into longitudinal folds or plaits. Upon slitting the vessel open, these folds are seen to be well marked, but without any division of the tunics; and by holding the vessel between the eye and the light, a decided transverse furrow or indentation, corresponding to the site of the ligature, is discernible, which

¹ *Op. cit.*, pp. 350, 351, Am. ed.

² *Operative Surgery*, vol. ii. p. 2, Am. ed.

might at first sight appear due to injury of one or more of the coats. The external and internal tunics can be made to glide over the furrow by the finger, showing that some lesion exists in the middle coat, and a superficial examination would leave the opinion that it had been completely divided. A minute examination and dissection, however, clearly disclose that only the inner layer of the middle coat, consisting of circular elastic fibres, has been cut, or rather separated, leaving the longitudinal fibres unharmed and closely connected with the uninjured external tunic. With the exception, then, of the impression made upon the inner layer of the middle tunic, none of the coats suffer division. The external tunic seems to be as strong as that of an artery in resisting a ligature. The middle tunic differs from that of an artery in having longitudinal as well as circular fibres, the former being composed of white fibrous tissue with elastic fibres, the latter of elastic fibres arranged in the same manner as those of an artery, with an admixture of a large quantity of unstriped muscular fibres. The inner tunic is more dense and tough, but not nearly as lacerable as that of an artery, and can be stripped off from the middle coat much more readily and to a greater extent. The inner tunic of the ascending cava has been peeled off in one unbroken patch of more than two inches, and on applying a ligature to it, it suffered no division. It is thus seen that the anatomical structure of a vein differs materially from that of an artery, and that, when ligatured, none of its coats are completely divided, as is the case with the latter vessel.¹ Ligatures, however, when tightly drawn around veins, always make enough impression on the deep layer of the middle tunic to keep them from slipping off from the ends after the vessel is severed.

Subsequently, the changes wrought by the application of ligatures to veins are strictly analogous to those which take place in ligated arteries. A coagulum forms on the distal side of the thread; it becomes organized, and unites with the inner tunic. If a ligature of animal origin, such as carbolyzed catgut, has been applied, the approximated walls grow directly together, and the ligature itself disappears by absorption, or is replaced by new connective tissue. But if a ligature of silk has been employed, as it cuts its way through the vein by ulceration, the tunics at the ends unite either by the first intention or by adhesive inflammation, and the obliterated portion is ultimately converted into a firm fibro-ligamentous cord. Veins may, and often do, undergo repair after ligature without any inflammation whatever, whether adhesive or otherwise, as Mr. Travers was the first to show. Three preparations illustrate this fact. One, in the Museum of St. Thomas's Hospital, is thus described: "Appearance of a vein divided by the ligature, which came away on the twenty-fifth day. The upper part of the vein is filled with firm layers of coagula, which so tenaciously adhere to the inner membrane as to be separated with difficulty; when separated, the surface was found to be perfectly smooth and natural." A second preparation, in the Museum of St. George's Hospital, shows the result of a ligature applied to the jugular vein of a horse for twenty-four hours. The inner vein-wall, thrown into longitudinal folds, is otherwise natural in appearance, whilst a good deal of lymph is accumulated externally around the ligature. The third, also in the Museum of St. George's Hospital, shows the effects of a ligature including part of the parietes of the jugular vein of a horse. Some fibrin is deposited in the track of the thread and in a small pouch below, but no evidence exists of any inflammation of the lining membrane, and this three days after the application of the ligature.² The results of tying the internal jugular vein in man, which were observed by Guthrie and Langen-

¹ S. W. Gross, *American Journal of the Medical Sciences*, April, 1867, pp. 320, 321.

² Holmes's *System of Surgery*, vol. iii., p. 357.

beck, as already mentioned, teach the same important lesson. In both, union by the first intention occurred. In Guthrie's case of lateral ligation, the healing was so perfect on the ninth day that there was no mark to indicate where the thread had been applied. In Langenbeck's case, an autopsy on the twelfth day showed the "vein completely healed, without trace of clot, redness, or thickening of its walls," that is, without any trace whatever of any inflammation.

All surgical observations prove that ligatures may fearlessly be applied to veins, as Dr. S. W. Gross has ably shown in an exhaustive article on wounds of the internal jugular vein and their treatment, published in the *American Journal of the Medical Sciences*, for January and April, 1867. The danger of exciting phlebitis and pyæmia by ligaturing veins is an exploded doctrine among surgeons. The dread of setting up diffuse phlebitis by ligaturing veins is based on prejudice, and not on experience; it is doubtless due to the influence of authorities who have pronounced against the operation (Bryant). This doctrine had its origin in the mistaken views on suppurative phlebitis and thrombosis which were current among pathologists some years ago, but which have long since been abandoned. The truth is, as I have just shown above, that the judicious application to wounded veins of carbolized catgut ligatures, or any other good antiseptic ligatures of animal origin, will lessen much the risk of diffuse phlebitis, putrefactive thrombosis, septicæmia, and pyæmia. In hemorrhages, too, from wounded veins, the antiseptic ligatures just mentioned should be fearlessly applied whenever advisable to restrain the bleeding. Lateral ligatures, however, should not be employed, from the risk of secondary hemorrhage which attends their use, as Roux's experience, to which I have already referred, has amply shown. Some writers advise, in similar cases, to stitch together the aperture in the side of the vein with a fine thread; but this practice, likewise, is a dangerous one, and altogether unreliable. Whenever veins are ligatured, an antiseptic thread of animal origin must be made to encircle the whole vessel; and a separate ligature must be passed around it on each side of the aperture in its walls. Moreover, wounded veins should always be tied in this way without delay, when pressure, properly applied, fails to restrain the hemorrhage.

Ligation of Artery and Vein simultaneously for Venous Hemorrhage.—When a large vein is wounded and bleeding, Professor Langenbeck recommends that, as an hæmostatic measure, the accompanying artery should be tied as well as the injured vein. He believes that "when both artery and vein are tied, not only does gangrene not follow, but there is less disturbance to the capillary circulation than when the vein or artery alone is tied." He states that, by simultaneous ligation of both artery and vein, "an equilibrium is maintained between the arteries and veins until the collateral circulation is established." Two observations which I have already presented strongly support these views. One of them was a case related by the late Dr. George McClellan (page 652), in which, the femoral vein being lacerated, the femoral artery was ligatured, the hemorrhage was easily restrained by compression, and the result was successful. The other occurred to Professor Agnew (page 652): in it, the hemorrhage from a punctured femoral vein ceased on applying a ligature to the accompanying femoral artery, and did not recur. That gangrene is not an inevitable result, and is but rarely to be expected in such instances, is well shown by the cases of Professor Grillo, of Naples, who included the femoral artery and vein in the same ligature in fifteen cases of aneurism of the ham or lower part of thigh. These were all successful; while in fourteen other cases, in which the artery was isolated and tied alone, there were two deaths from secondary hemorrhage.¹

¹ *American Journal of the Medical Sciences*, April, 1867, p. 334.

During the late civil war, in a case of secondary hemorrhage to the amount of twenty ounces, from a gunshot wound of the armpit, the axillary artery was ligated above and below the wound; and the axillary vein, being injured, was also tied. The bleeding did not recur, but death ensued on the thirteenth day after the operation, apparently from anæmic exhaustion. *Autopsy*—No evidence of phlebitis or pyæmia was found.¹

In another case of secondary hemorrhage, the basilic vein, being open, was tied as well as the brachial artery, above and below the wound. This man recovered.² I have in one case, however, where the femoral artery and vein were both opened in a gunshot wound, seen gangrene ensue after the simultaneous ligation of these vessels:—

Private D. R., "K," 7th Indiana, aged 20; wounded November 30, 1863; a conoidal bullet passed from behind directly through the left thigh, dividing both femoral artery and vein, and escaping from Scarpa's space; admitted to hospital, Washington, December 6; operated on December 9, by Dr. Wm. Thomson, because the aneurismal condition was increasing. He laid the tumor freely open, and found the vessels severed just below the origin of the profunda. He tied each end of both artery and vein. Mortification of the limb followed, and death ensued on the 13th. I saw this case in consultation. Amputation was then out of the question. The man was very pale. His limb was already much swollen and œdematous, looking not unlike the limb in *phlegmasia alba dolens*. The aneurismal swelling was likely soon to burst. His general condition was failing. The operation was, therefore, one of expediency. In this case, the gunshot wound, the hemorrhagic infiltration, and the inflammatory swelling of the thigh, made the establishment of a collateral circulation much more difficult after the operation, which was performed on the ninth day, than it would have been had the operation been performed without any delay; and it is quite possible that, had the deligation of both artery and vein been practised at the outset, and before the advent of any swelling, the occurrence of gangrene would have altogether been avoided. At any rate, it is scarcely fair to infer that a primary ligation of the severed vessels would necessarily have been followed by gangrene.

When the femoral vein is wounded, but especially in the upper part of its course, it may be very difficult, or even impossible, to stay the bleeding, unless the femoral artery is ligatured. This fact is well shown by Oettingen's case:—

During the removal of a tumor situated in the fossa ovalis, he wounded the femoral vein, and therefore tied both ends of it. Notwithstanding this double ligation, the hemorrhage continued, and the leg became cyanotic. In order to arrest the venous hemorrhage, and to correct the inequality between the afflux and reflux of blood, he tied the common femoral artery. The hemorrhage ceased and the cyanosis disappeared. Gangrene did not ensue.

In a case recorded by Rose, there was a punctured wound of the femoral artery and vein, in a butcher, aged 25. Both vessels were ligated *in loco*, at their proximal and distal ends; the vein had been split by the knife, "directly under Poupart's ligament," the artery a little lower, "nearly under Poupart's ligament." The patient completely recovered, without even œdema of the limb appearing during the after-treatment.

Tillmanns ligated the common femoral artery below Poupart's ligament for profuse hemorrhage from numerous large veins, after the extirpation of a vascular sarcoma of the thigh, the size of a man's head. The hemorrhage was promptly arrested and the patient recovered.³ Other examples of similar import might be adduced. Beyond doubt, then, it is often, perhaps generally, a good hæmostatic measure in wounds involving the femoral or axillary veins, to ligate the accompanying artery as well as the vein itself.⁴

¹ Medical and Surgical History, etc., First Surgical Vol., p. 555.

² *Ibid.*, p. 446.

³ International Journal of Medicine and Surgery, vol. i. pp. 224-227.

⁴ When hemorrhage from the common femoral vein makes deligation of that vessel necessary in order to stop the bleeding, the common femoral artery should also be ligatured in most cases, in order to equalize the circulation in the limb, as recommended by Langenbeck. "Under these circumstances, it may be hoped that still other successful ligations of the injured vena femoralis

Not so, however, in wounds involving the internal jugular vein. The great freedom with which the blood can pass from one jugular to the other through the lateral sinuses, etc., and can be returned toward the heart in this way in case one of them is ligatured, makes it quite unnecessary to tie the common carotid artery in order to equalize the afflux and reflux of blood in the head, when the corresponding jugular vein is closed by ligation. For the same reason, the ligation of a common carotid artery will not restrain the flow of blood from a wounded fellow internal jugular vein; and, therefore, it must be rejected as a hæmostatic measure in such cases.

ENTRANCE OF AIR INTO VEINS.—The entrance of air into veins is a most dangerous accident. I can describe it most briefly and accurately by presenting some examples. The first instance on record was observed in 1818 by M. Beauchesne, while removing a large tumor from the right shoulder. He accidentally opened the external jugular vein, just above its termination in the subclavian, during the extraction of a part of the clavicle; air entered the partly divided vein, and in a quarter of an hour the patient died. In 1822, a striking example of this mishap occurred to Dupuytren:—

He was excising a tumor from the postero-lateral part of the neck of a healthy young woman, and, while an assistant raised it up, as he was severing its last attachments a prolonged blowing sound was heard in the wound. "If I were not so far from the air-tubes," said Dupuytren, "I should think we had opened them." The words were scarcely uttered when the girl exclaimed, "Je suis morte;" she trembled, and fell dead. A large vein, connected with the tumor and communicating with the internal jugular, was cut by the last stroke of the scalpel while the tumor was forcibly drawn up. This vein adhered to the sides of a sulcus, so that it remained gaping when cut. The right auricle was found distended with air, which rushed out, unmixed with blood, on laying it open; the other chambers of the heart contained fluid blood. In all the vessels there was much air mixed with blood. No other abnormality was observed.

Many examples of this accident have been reported. In 1829, Amussat had already collected thirty-nine cases. They continued to happen with considerable frequency until the use of anaesthetics during surgical operations became general. Since that time, their occurrence has been very rare. Indeed, it is not difficult to perceive that anaesthesia, by eliminating from surgical operations on the neck, breast, and armpit, the struggles, cries, groans, and sobs, and the deep gasping inspirations they cause, which formerly obtained, must considerably diminish the risk of air being drawn into wounded veins, in those regions, by the suction power of the chest.

Two examples, however, were reported during the late civil war. In one of them, death occurred within two minutes, in the other in from seven to ten minutes after the mishap.

The following is a brief account of these cases:—

1. Private E. M. D., Co. E, 1st Maine Heavy Artillery, aged 21, was wounded May 12, 1864, by a conoidal ball, which fractured the left temporal bone and lodged in the neck. On May 22, during an operation for extracting the ball and fragments of bone, hemorrhage from the internal jugular vein took place, and within two minutes death occurred. Surgeon N. R. Mosely, U. S. Volunteers, ascribed the almost instantaneous death of this patient to the entrance of air into the internal jugular vein, which was

communis at the ligamentum Poupartii may be added to those already known, the more so, as by means of the antiseptic method of operating, uninterrupted recoveries are more easily obtained; that is, diffuse inflammatory infiltrations of the soft parts and extensive phlebitis are prevented. And especially as these compressing, extensive inflammatory infiltrations with phlebitis are very probably the main cause of gangrene after ligation of the arteries as well as after ligation of veins." (Tillmanns.)

found largely opened by ulceration.¹ This case is probably unique, for Dr. S. W. Gross asserts that there is not a single recorded instance of death from this accident following a gunshot injury of the internal jugular vein.

2. In the next example of air in veins, the axillary vein was accidentally opened while searching for the artery: Private E. C. Melley, Company K, 2nd West Virginia Mounted Infantry, was wounded November 6, 1863, by a musket-ball, which entered one inch and a quarter below the middle of the clavicle, and emerged near the middle of the inferior border of the scapula. When admitted to hospital on the 18th, an enormous tumor of coagulum distended the axillary space in every direction, and rendered the surrounding tissues tense; the subcutaneous veins covering it were enlarged. During his removal to hospital, considerable blood was lost from the anterior orifice; the posterior orifice was closed and nearly healed. On the 19th, an attempt was made to secure the axillary artery in the midst of this immense clot, at the place where it was wounded. But, in searching for the artery, the axillary vein was accidentally opened; the entrance of air caused syncope, and death ensued in from seven to ten minutes. After death the axillary artery was found almost completely divided about one inch before it becomes the brachial.²

This accident has most frequently been observed in the great veins at the root of the neck and in the armpit. The internal jugular was the seat of the mishap in twelve instances collected by Dr. S. W. Gross, with six deaths and six recoveries. Ten of them occurred while extirpating tumors of the neck, with five deaths and five recoveries; and two in cut-throats or attempted suicides, with one death and one recovery.³ To these twelve cases a thirteenth, just now related, must be added, in which death from air in veins followed a gunshot lesion of the internal jugular. Moreover, these cases show that the accident is more liable to occur when the vein is opened near its termination in the innominate, as at this point, as well as throughout almost the whole of its lower third, the phenomena of venous inspiration may be witnessed, that is, the free sucking of air and blood, at each inspiratory effort, into the open mouth of the vein, when wounded or divided by an external injury.

This accident, too, has not unfrequently occurred in the subclavian and axillary veins. I have already presented one example in which the axillary was wounded, that occurred during our civil war. In a case recorded by Delpech, there was hypertrophy of the axillary vein, causing it to gap like an artery, so that the air entered in when it was opened.

Bransby Cooper⁴ having secured the vessels after amputating an arm at the shoulder-joint, proceeded to remove a gland from the axilla, and, while dissecting it out, heard a peculiar gurgling noise, like air escaping with fluid from a narrow-necked bottle; the patient instantly became collapsed; countenance deadly pale; pupils fixed and inobedient to light; pulse quite small and fluttering, although, at intervals, regular; respiration hurried and feeble, and, at irregular intervals, attended with a deep sigh; left leg apparently paralyzed. She continually uttered a whining cry. Symptoms of great prostration continued for several days, but she eventually recovered. When she left the hospital, six weeks after the operation, she still dragged the left leg in walking.

While Roux was disarticulating an arm at the shoulder by the method of Desault, a peculiar whistling sound of air was suddenly and very distinctly heard. Pallor, syncope, convulsive movements, and death ensued. *Autopsy*—Right ventricle soft, and distended with a mixture of air and blood; globules of air in the coronary veins; contents of vena cava superior, spumous.⁵

¹ Med. and Surg. History, etc., First Surg. Vol., pp. 255, 256.

² Ibid., p. 555.

³ Loc. cit., pp. 38, 39, 329, 333, 338, 339.

⁴ Medico-Chirurgical Transactions, vol. xxvii. p. 14.

⁵ Journal des Connaissances Médico-Chirurgicales, Septembre, 1836, pp. 108, 109.

Dr. Mussey, in 1837, extirpated the clavicle and scapula, six years after amputating the arm. At the moment of tying the subclavian artery, a faint gurgling sound was heard, and a bubble of air was seen in the mouth of the subclavian vein. The man uttered a faint cry; his eyes rolled and became fixed; his neck and face were covered with cold sweat; his pulse was imperceptible; there was loss of consciousness during eight or ten minutes; finally, however, the patient recovered.¹

Mr. Jessop did a primary amputation of the upper extremity, including the scapula and outer half of the clavicle, for a severe injury.² While removing the scapula, air was heard to enter the subclavian vein. The patient was suffering from extreme shock at the time, and was almost dead; but he rallied, and at the end of three weeks the wound was healed.

The spontaneous entrance of air into the venous system has also occurred, not unfrequently, during surgical operations which laid open the lesser veins of the sub-clavicular, axillary, and sub-scapular regions, as well as those which involved the subclavian and axillary veins.

For instance, on July 4, 1837, Amussat extirpated the right mamma, and, while cutting into some suspected tissue under the right clavicle, he suddenly heard a distinct interrupted sound, as of air passing into a cavity through a narrow opening. Syncope, with cold sweats, etc., ensued, but in the end recovery took place. So, too, a case occurred to Warren, in which the air entered by the sub-scapular vein, the coats whereof were healthy, but in a state of tension, in consequence of the position of the arm. In a case reported by Castara, there was incomplete section of a vein which opened into the sub-scapular, whilst the tumor was raised up, and in this way the air entered.³

I have thus presented nine examples in which air was drawn into the veins of the axilla, both great and small, by the movements of thoracic inspiration, during operations for amputation as well as for the extirpation of tumors.

But air has often been drawn into the small veins of the neck when wounded, as well as into the large or deep jugular vein, by the movements of thoracic inspiration. I have already presented two such examples. In Dupuytren's case, a vein communicating with the internal jugular was cut. In Beauchesne's case, the external jugular was partially divided. Besides, there are on record at least three other cases in which air was sucked in through a wounded external jugular vein:—

Rigaud⁴ opened a vein which he believed to be the external jugular, while ligaturing the subclavian artery above the clavicle. The sound of the drawing of air into the vein was heard three different times.

Malgaigne relates a case in which the accident happened in consequence of the incomplete section of the external jugular vein, where it was enveloped by a tumor that was being removed.

Manec, while ligaturing the subclavian artery for aneurism, opened the external jugular vein, and air was drawn in. The patient's head was thrown back; the eyes were convulsed; the face became pale; but recovery followed.

Again, the same accident happened in a case reported by Warren, in consequence of the division of a small transverse branch of communication between the external and internal jugulars, whilst in a state of tension.

Moreover, this mishap has ensued from the wounding of a small vein high up in the neck. For instance, Mott, on dividing the facial vein while removing a parotid tumor, heard the gurgling sound of air passing into some small opening. "The breathing of the patient immediately became difficult and laborious, the heart beat violently and

¹ American Journal of the Medical Sciences, February, 1838, p. 390.

² British Medical Journal, January 3, 1874.

³ American Journal of the Medical Sciences, November, 1837, p. 233.

⁴ Thèse. Paris, 1836.

irregularly, his features were distorted, and convulsions of the whole body soon followed to so great an extent as to make it impossible to keep him on the table. He lay on the floor in this condition for nearly half an hour, as all supposed him in *articulo mortis*. As the convulsions left him, his mouth was permanently distorted, and complete hemiplegia was found to have ensued; an hour or more elapsed before he could articulate, and it was nearly a whole day before he recovered the use of his arm and leg."¹

Le Gros Clark mentions a case belonging to the same category, but also remarkable for the slowness with which the air was sucked into the vein, and the tardiness with which the symptoms appeared.² The incision was above the hyoid bone. Dyspnœa came on gradually, and increased until death ensued, in about twenty-four hours. At the *autopsy*, the blood in the heart was found churned up and frothy. Examination of the wound showed that a half-divided vein, ligatured only on the distal or bleeding side of the aperture, had slowly drawn into its open mouth the air which, admixed with the blood, had proved fatal.

"*Dangerous Region.*"—That there is a space of considerable size, embracing portions of several regions, in which there is a special danger in performing surgical operations, caused by the liability of air to be drawn into wounded veins by the movements of thoracic inspiration, these thirty examples just presented very clearly prove. They also show that this dangerous space embraces almost all of the cervical region, together with the sub-clavicular, the axillary, and the sub-seapular regions, and that the liability to get air in veins increases, on either side, with growing nearness to the brachio-cephalic trunk or the innominate vein. They show, too, that the careless gashing of small veins within these limits is almost as dangerous as that of the large ones; and that the veins to be especially avoided are the external and internal jugulars, the subclavian, the axillary, the thoracics, and the sub-seapular. The operations that need most caution in this regard are amputation at the shoulder-joint, disarticulation of the clavicle and scapula, deligation of the subclavian and other arteries, and the extirpation of tumors, from those consisting of scrofulous glands no larger than a small nut, all the way up to those as large as a child's head.

I must mention some examples of air in veins, which, although not of special interest to operating surgeons, still have enough of importance to demand recognition in this place. For instance, a case is mentioned by Dr. S. W. Gross in which air entered a large vein that was opened by ulceration. One of the jugulars communicated with an open sore through an aperture in its walls made by ulceration. There was a slight bleeding, followed by a gurgling sound, etc., and alarming syncope; from which, however, the woman gradually recovered under the use of stimulants.³

Dr. Cordwint relates a case in which he thinks death was caused by air entering the veins of the uterus after labor.⁴ Professor John C. Dalton, Jr., mentions a case in which a gutta-percha catheter was used to rupture the membranes and procure abortion. The patient fell back and died. Air was found in the veins and heart; and it was believed by the surgeon that air had been blown in through the catheter, in order to produce the effect desired.⁵ Depoul related to the Surgical Society of Paris a case in which the douche was used for the purpose of inducing premature labor. A gurgling noise, like that of air, attended the use of the instrument; and suddenly the woman died. On making the Cæsarean section for extracting the child post-mortem, air escaped in cutting into the uterus; the uterine tissue was bright red, and the blood was frothy.⁶

Dr. Parise observed several cases of sudden death in gangrene of the limbs, and in each instance believed that this result was caused by the entrance of putrid gas into the

¹ Gazette Médicale, 1831.

² British Medical Journal, August 21, 1869.

³ American Journal of the Medical Sciences, April, 1871, p. 337.

⁴ St. George's Hospital Reports, vol. iii.

⁵ American Medical Monthly, June, 1860.

⁶ Lancet, July, 1860.

veins, and thus into the heart. Maisonneuve, in 1853, published several cases of rapid gangrene with the development of putrid gas in the veins; but he believed that death was caused by blood-poisoning from this source. Dr. Parise, however, affirms that the putrid quality of the gas determines no septic action, but that the gas produces death in the same way that air does when it accidentally enters the veins.¹

The entrance of air or gas into the veins caused sudden death in one case during the Crimean war: A soldier, aged 20, sustained a gunshot fracture of the left leg, June 18, 1855. On September 21, amputation immediately above the knee was performed; but the stump did badly, the discharge being thin, watery, copious, and slightly fetid. At 1 A.M., on the 25th, he was found, unexpectedly by the orderly, quite dead in bed, and nearly cold, although he had conversed with the man in the next bed as late as 11 o'clock. *Autopsy*—Lungs healthy, but somewhat anæmic. Right auricle distended with bright red froth (air or gas mixed with blood); right ventricle also distended, but the proportion of air was less; heart otherwise healthy. Inferior cava, too, distended with scarlet-colored, frothy blood, "so that it felt like a portion of small intestine before it was cut into." Interior of stump sloughy, with no attempt to unite; flaps separated to some extent by fetid gas; the femoral vein lay quite open on the face of the stump, with no attempt at closure, but no sloughing.² Had the femoral vein been ligatured in this stump, such a mishap could not have occurred.

Causes.—The above presented examples of this accident that took place in the dangerous region, show its causes to be the following: (1) The suction-power exerted by the inspiratory movements of the thorax upon the innominate and its tributary veins throughout the dangerous region. This suction-power is exhibited by a movement of afflux and reflux of blood in these veins, synchronous with the inspiratory and expiratory movements of the thorax. (2) The gaping of the mouth of the wounded vein which solicits the air to enter. This gaping in many situations is due to the adherence of the fascia or aponeurosis to the sides of the vein, whereby it is held open when wounded or divided. The contractions of the platysma and other muscles of the neck have a similar effect. (3) The "canalization" of veins, or their conversion into rigid, uncollapsing tubes—(a) from inflammatory thickening of their tunics, (b) from being surrounded by indurated connective tissue, or (c) from being imbedded in tumors—is an exceedingly favorable condition for the introduction of air into them. (4) The patulous state of veins may be caused by the surgeon himself in lifting up tumors, in making the neck tense by extending the head, in making the axilla tense by extending the arm, also by notching the walls of veins, and, finally, by neglecting to place a proximal as well as a distal ligature around a wounded vein, as happened in the case mentioned by Le Gros Clark.

Symptoms.—When the air enters a wounded vein, a whistling, hissing, sucking, gurgling or lapping sound is usually heard; bubbles of air often appear in the wound; a deathly pallor spreads over the face; the pulse becomes small and weak, or nearly imperceptible, and the heart's action laboring, rapid, and feeble; the respiration is labored or embarrassed, short, and hurried; the eyes are fixed, and the pupils widely dilated; if the quantity of air admitted be small, these symptoms may disappear after a time, and recovery ensue; but if the quantity be large, syncope with convulsions and fatal collapse soon follow. The symptoms, however, may be masked by the anæsthetic action of chloroform or ether. Hence the reports of cases of this accident are, as a rule, much less dramatic since the introduction of anæsthesia. It is not improbable that some of the deaths attributed to chloroform have in reality been due to air in veins.

A whistling, hissing, or sucking sound which is not due to the entrance

¹ Archives Gén. de Médecine, Novembre, 1880.

² Medical and Surgical History of the Crimean War, vol. ii. p. 277.

of air into a wounded vein, is sometimes heard during operations in the dangerous region. It may occur on opening the deep fascia of the axilla when made tense by extending the arm, or that of the neck when made tense by extending the head, or that of any space similarly protected from atmospheric pressure. Of course there are no constitutional symptoms in such a case. The following is a good example:—

In 1830, Professor A. H. Stevens, at the New York Hospital, while extirpating a large flattened tumor under the left sterno-mastoid muscle, having detached it completely, except at its postero-inner edge, drew the tumor outward and forward, and divided, near its junction with the internal jugular, a vein of considerable size. Half an ounce of venous blood escaped; in an instant afterward a peculiar sound, like that caused by drawing into a syringe the last portion of water from a basin, was heard. "It was a moment of intense anxiety," says Professor Stevens, "for the fate of Dupuytren's patient was fresh in my recollection. I immediately placed my finger on the aperture in the vessel, seized the pulse with my other hand, and watched the patient's countenance. All seemed well, and the patient's reply to my interrogatory confirmed the favorable indications." He treated the wounded vein by ligaturing the internal jugular above and below its place of entrance. The ligatures came away on the fourteenth day, and the case went on without any peculiarities.¹

The following is likewise a pseudo-example of air in the veins:—

Professor Verneuil, while removing a tumor of the right parotid gland, divided a vein (the external jugular or one of its branches) while separating the supra-clavicular prolongation of the tumor; a whistling sound indicated the passage of air into the vein; the latter was instantly compressed, then tied; but no change occurred in the pulse or breathing. The operation was completed, and the case progressed satisfactorily afterward.² It is far more likely, however, that the air did not enter the vein at all, but, instead thereof, passed into the loose connective tissue under the deep cervical fascia, in this as in the preceding case.

Pathology.—Examinations after death from this accident show air mixed with blood in the right auricle and ventricle, often beaten up together into a spumous froth, with a similar spumous froth in the superior cava and other veins, and an unusually bloodless appearance of the lungs. Several explanations of the cause of death have been offered, none of which, however, are quite satisfactory. Among the most plausible of them is that which supposes that the air is carried into the right ventricle, and that, during the contraction of the right ventricle, the presence of this air prevents the closure of the tricuspid and the semilunar valves, in consequence of which the two orifices which they guard remain pervious in both the systole and diastole of the heart, allowing the air to reach the pulmonary arteries, and in this way preventing the entrance of blood; hence there is a deficient supply of blood to the brain and nervous centres, and fatal syncope comes on, attended generally by convulsions. The heart's action usually continues some time after respiration has ceased. Some who have recovered from the immediate effects have died from pneumonia.

Treatment.—The securing of equal and regular breathing in the patient, throughout operations in the dangerous region, by duly regulating the administration of anæsthetics, is an important precaution against this accident, which should never be neglected. The surgeon himself should avoid all the causes of this accident which depend upon his own conduct during the operation. There should be as much relaxation of the parts allowed as may be compatible with the safe or convenient performance of the operation. The

¹ Cooper's Surgical Dictionary, Supplement, Am. ed., pp. 165, 166.

² Gazette Hebdomadaire, 1863, p. 722.

relations of the veins should always be considered before any incisions are made, throughout the operation. Tumors should be detached from their surroundings, as far as practicable, with the handle instead of the blade of the scalpel; and all veins which it is not necessary to cut should be pushed aside. When it is necessary to divide a vein in the course of the operation, pressure should be made above and below, and should be continued on the cardiac side until the end of the divided vein is securely tied. But especially, when prying out adherent tumors from the deep parts of the neck, or of the axilla, should the surgeon have firm pressure made by his assistants upon the contiguous veins, both above and below. When disarticulating the clavicle, special pains should be taken to avoid notching the external jugular vein. When deligating the subclavian artery, special pains should also be taken to avoid wounding the same vein. In amputating at the shoulder-joint, the liability for air to enter the axillary vein, when cut into while the arm is extended, should be suitably met by the application of pressure.

But should, unfortunately, the air enter a vein, the surgeon must immediately place a finger on the orifice, and pass a ligature around the wounded vessel, on the cardiac as well as on the distal side of the aperture. By seasonably stopping the ingress of air in this way, many subjects of this mishap have been saved. The symptoms of alarming syncope, and the threatened collapse, must be met by lowering the patient's head, by artificially maintaining the respiration, and by the subcutaneous or rectal administration of diffusible stimulants, such as ammonia and brandy. It may, too, be remembered with possible advantage that dogs have been restored by artificial respiration continued for one-half or three-fourths of an hour, when very considerable quantities of air had entered the veins. As a remedial measure of last resort, if time permit, a few ounces of blood may be transfused.

WOUNDS OF THE AORTA, INNOMINATE, AND SUBCLAVIAN ARTERIES; THE VENÆ CAVÆ, AND VENÆ AZYGOS; THE HEART, PULMONARY ARTERY, AND PULMONARY VEINS.

Brief mention must be made of this important class of injuries. Wounds of these vessels very rarely come under surgical treatment. The subjects almost always perish from hemorrhage, or from shock, before surgical aid can be obtained.

WOUNDS OF THE AORTA.—The following example in which the *aorta* was punctured by the blade of a penknife is to the point:—

James Donohue, aged 8 years, living in the rear of No. 90 Catharine Street, went out about 9 o'clock P. M., on May 1, 1881, to buy an apple. In a few minutes he came back, and meeting his sister, said: "A boy as big as you are has stabbed me." There was a small wound in his breast, and soon he fainted in his sister's arms. He failed rapidly, and although he was taken in an ambulance to the Chambers St. Hospital, he died before midnight of internal hemorrhage. The wound was made with the narrow blade of a penknife, which entered the chest just below the third rib, and punctured the aorta. Afterward, it was shown that the stabbing had been accidental. He lived about two and a half hours.

During the civil war no one wounded in the aortic arch, or in any part of the *thoracic aorta*, lived long enough to receive hospital treatment. Dr. J. B. White mentions a case of bayonet-stab causing a small puncture in the aorta, a few lines external to the pericardium, which proved fatal from hemorrhage. But, since the war, Dr. W. J. Piper reports an accidental pistol-ball perfora-

tion of the aortic arch, the wounded soldier having lived long enough to be carried across the parade-ground to the post hospital, at Baton Rouge.¹

But in the following example, where the *abdominal aorta* was injured in the late civil war, the patient survived the casualty forty days:—

A soldier was wounded, on July 3, 1863, by a conoidal ball, which entered his chest at the right nipple, and lodged. He did badly. About August 1, he rapidly grew worse. A pulsating tumor was discerned in the umbilical region, which steadily grew larger. He sank gradually, and died on August 12, of anæmia. *Autopsy*—The missile, entering the thorax at the right nipple, passed inward, downward, and backward through the diaphragm, by the side of the aortic sheath, and lodged in the body of the fifth lumbar vertebra, half an inch to the right of the median line. Just above the point of lodgment, a large aneurismal sac communicating with the aorta was found; it was partially emptied, and there was a large quantity of coagulated blood found extravasated beneath, that is, external to the peritoneum, on the left side of the spine, amounting to almost two pounds. The aorta, elsewhere, was healthy.² The bullet grazed the sheath of the aorta, in this instance, and its tunics, being weakened by the textural disintegration, gradually yielded until they burst and allowed a traumatic aneurism to form.

Wounds of the great bloodvessels of the trunk are usually passed over cursorily by systematic writers on surgery, and the information concerning them is scattered through theses, monographs, and collections of cases. Guattani³ records the case of a man who survived an incised wound of the arch of the aorta eight years. Pelletan⁴ relates the case of a man who lived two months after a puncture of the aorta, near its origin, by a foil. Heil⁵ details a case in which the patient lived twelve months after receiving a stab in the ascending aorta. T. M. Green, of Macon, Ga.,⁶ publishes an account he had from Dr. J. B. Wiley—"a competent and reliable observer"—of an autopsy held on a man stabbed, a month previously, in the aorta near its origin, with a narrow blade. In the *Journal de Médecine*⁷ is a similar history, of a man who lived six days. Lerouge inserted in Saviard's *Observations Chirurgicales*, which he edited, a similar case, the patient surviving eleven days. Legouest⁸ quotes a unique instance of recovery from a punctured wound of the aorta, observed by Dr. Neil, of Bamberg, in 1812, the cicatrix having been verified a year subsequently, at the autopsy, after the occurrence of death from pneumonia. Demme saw a young Austrian perish from secondary hemorrhage four weeks after the reception of a gunshot injury of the descending part of the thoracic aorta. Cases of rupture of the aorta from external violence have been recorded by Morgagni,⁹ Laurencin, and St. Leger,¹⁰ and a specimen of this lesion is preserved in the Museum of St. Bartholomew's Hospital.¹¹ There is also a preparation by Professor Theile in the Museum of Pathological Anatomy, at Bern, showing a laceration of the arch of the aorta which was not fatal until several months after the accident.

Our Army Medical Museum contains two specimens of gunshot lesion of the abdominal aorta, in one of which the artery is fairly perforated by a pistol-ball.¹² M. Legouest¹³ saw a case of transverse laceration of the left side of the aorta, one-fourth of an inch long, three fingers-breadth above

¹ Med. and Surg. Hist. of the War, etc., First Surg. Vol., p. 519.

² Ibid., Second Surg. Vol., p. 189.

³ *Scriptorum Latinorum de Aneurismatibus* Collect. ed. Lauth, pag. 178. Argent, 1785.

⁴ *Clinique Chirurgicale*, t. iii. p. 241.

⁵ Henke's Zeitschrift, 1837, Bd. ii. S. 459.

⁶ *Southern Med. and Surg. Journal*, 1855.

⁷ *Journal de Médecine*, t. xlv. p. 435.

⁸ *Chirurgie d'Armée*, 2e éd., p. 333.

⁹ *De Sedibus et Causis Morborum*, Epist. liii.

¹⁰ *Thèse de Montpellier* (MS.), quoted by Bérard.

¹¹ Med. and Surg. History, etc., First Surg. Vol., pp. 519, 527, Foot-notes.

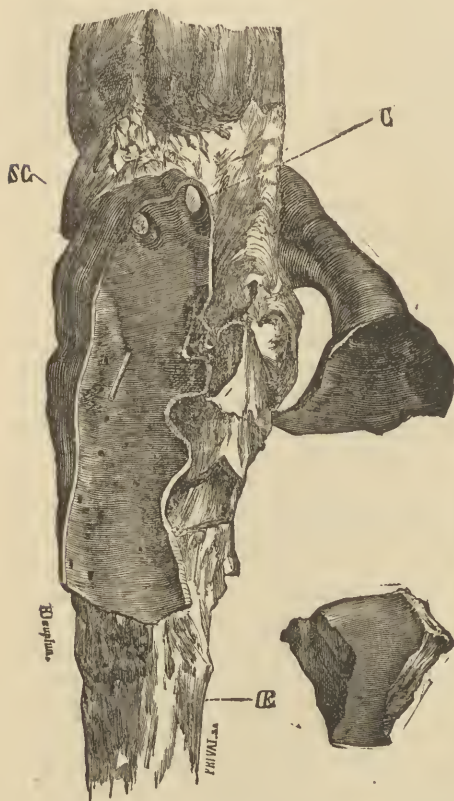
¹² Specimens 910, 4085, Sect. I., A. M. M.

¹³ Op. cit., 2me éd., p. 372.

the promontory of the sacrum, in a farrier, who received a kick from a horse at the level of the umbilicus. The bleeding, which, of course, was internal, proved rapidly fatal. Doubtless other arteries of the abdomen may be ruptured without external wound.

The aorta has occasionally been punctured by foreign bodies which had entered it from the œsophagus. I have already presented two such examples in the section on Punctured Wounds of Arteries. The aorta, too, has not unfrequently been opened by ulcerations caused by foreign bodies penetrating it from the œsophagus. The next four wood-cuts illustrate this accident.

Fig. 430.



Perforation of the aorta by a swallowed bone. The point of perforation is indicated by a stylet. C. Carotid artery. SC. Subclavian artery. E. Esophagus. The bone is represented at the side. After Shetter (Archiv f. klin. Chir., 1878). Taken from Poulet's Foreign Bodies in Surgical Practice, vol. i. p. 90, Am. edition.

Fig. 431.



Perforation of the œsophagus and aorta by a five franc piece. (Denonvilliers, Musée Dupuytren.) Taken from Poulet's Foreign Bodies in Surgical Practice, vol. i. p. 93, Am. ed.

Poulet¹ has collected thirty-three instances of the perforation of bloodvessels by foreign bodies lodged in the œsophagus. In these cases, however, the perforations were effected by *ulcerations* caused by the foreign bodies, that is, the perforations were secondary to eschars, which, by gradually becoming deeper, finally involved the walls of the vessels. In 17, or over one-half of these 33 cases, the *aorta* was the vessel perforated; in 4 the *common carotid artery*; in 2 the *vena cava*; in 1 the *inferior thy-*

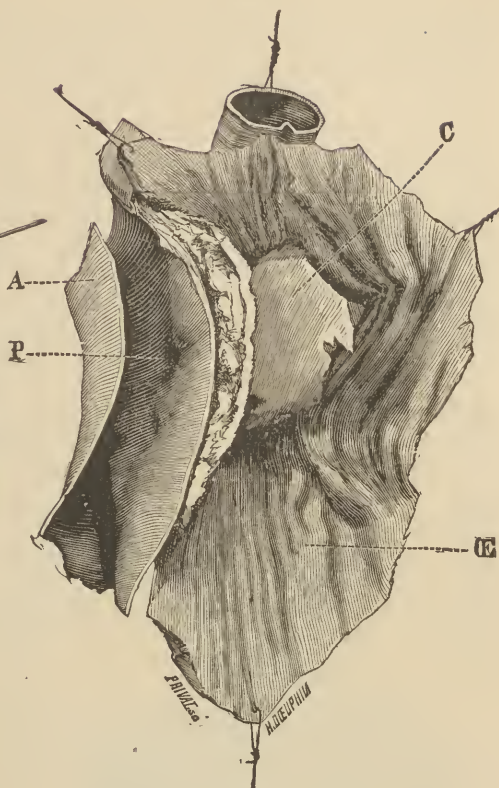
¹ Foreign Bodies in Surgical Practice, vol. i. p. 91, Am. ed.

Fig. 432.



Perforation of the inferior thyroid artery by a swallowed bone. (Pilate, Musée Dupuytren.) Taken from Poulet's Foreign Bodies in Surgical Practice, vol. i. p. 94, Am. edition.

Fig. 433.



Perforation of the aorta and oesophagus by a very irregular bone. (Bousquet, Musée Dupuytren.) A. The aorta. P. The perforation. C. The foreign body. OE. The opened oesophagus. Taken from Poulet's Foreign Bodies in Surgical Practice, vol. i. p. 95, Am. edition.

roid artery; in 1 the right coronary vein; in 1 the vena azygos; in 1 the right subclavian artery (abnormal); in 1 the oesophageal arteries; in 1 the pulmonary arteries; and in 4 cases the arteries penetrated were *unknown*, as autopsies were not made.

The position of the oesophagus in the midst of the large vascular trunks of the neck and chest sufficiently explains the frequency of this grave accident. These vessels are: 1st, the aorta, which is situated behind and to the left of the oesophagus; 2d, the vena azygos; 3d, the pulmonary artery; 4th, the superior vena cava; 5th, the carotid; 6th, the inferior thyroid artery; 7th, the right subclavian artery, when abnormally situated; 8th, the oesophageal arteries. The much greater frequency of aortic perforations is not wonderful, in view of its great size, and of the intimate manner in which the two organs are connected over a considerable space.

The foreign bodies causing this accident have most often been pieces of bone. Next in the order of frequency are coins, fish-bones, artificial teeth, etc., and any irregular, dense, flattened, or pointed body can produce it. After what lapse of time are these perforations of bloodvessels developed? This period is very variable. In a large majority of the cases, however, the first hemorrhage occurs from the fifteenth to the twenty-fifth day; but the exceptions are numerous. Moreover, surgical interference is not immaterial; and, more than once, it has happened that the surgeon has forced a foreign body, which he thought he had pushed into the stomach, into the oesophageal walls. Such a manipulation would only, by so much, hasten the occurrence of vascular perforation and hemorrhage. In such cases, too, the appearances may be very decep-

tive. Thus, Wagret's patient, after a physician had made attempts to propel the bone, "experienced entire relief, and said to his benefactor that he thanked him very much, and that he had saved his life." But a few days later this patient died of perforation of, and hemorrhage from, the descending aorta. (Poulet.)

The first hemorrhage, in these cases, generally does not cause death; it ceases, for the time being, and the patients merely remain in a state of extreme weakness. Surgeons have been struck by this intermittence of the hemorrhage, and have endeavored to explain the manner in which a vessel as large as the thoracic aorta may cease to bleed after its walls are perforated. Shetter attributes the intermittence to two causes: 1, a temporary occlusion of the opening in the artery; 2, the weakness of the cardiac contractions. The process is a natural hæmostasis, like that described by Valsalva. The blood, being pushed with less force by the weakened heart, and being changed in composition, is in a condition the most favorable for forming obstructive clots. But when the heart recovers its energy, and the condition of collapse gives place to commencing reaction, the clot is displaced, and the hemorrhage reappears. The interval between the hemorrhages is usually not considerable, varying from a few hours to a few days. In some cases, especially when the perforation is small and is situated low down, all the blood extravasated flows into the stomach and thence passes into the intestines. The patient then suddenly presents, in the midst of perfect health, all the symptoms of an internal hemorrhage, whose explanation is very difficult. In one case this internal hemorrhage was manifested by some colicky pains, as the only subjective symptom. It is hardly necessary to add that all the remedial measures thus far tried have proved fruitless.¹

WOUNDS OF THE INNOMINATE.—During the late civil war, two cases in which the innominate artery was wounded came under treatment. The first patient survived twenty-four days, as follows:—

A soldier, aged 20, was wounded July 1, 1863, by a rifle-ball, which entered above the clavicle, passed behind the sternum, and emerged between the fourth and fifth ribs. On the 22d, hemorrhage from the arteria innominata occurred, for which compression was applied. Death followed on the 25th.²

It is highly probable that in this case the missile contused the tunics of the innominate artery, and that the bruised tissue exulcerated or separated as a slough at the end of three weeks, whereby the canal of the artery was opened, thus allowing a secondary hemorrhage to ensue.

The second patient lived six days after the casualty, as follows:—

A soldier, aged 26, was wounded October 27, 1864, by a conoidal ball, which entered at the right upper angle of the sternum, passed behind the clavicle, and lodged in the thorax. The wound was plugged with lint, and the man was kept as quiet as possible. On the 31st, under chloroform, the wound was explored for the ball, which caused profuse hemorrhage. Plugging the wound, with the use of a compress and bandage, was the only resource. On November 1, the patient had much dyspnoea, caused by hæmothorax. The trachea was compressed by blood extravasated in the mediastinum. On the 2d he died. *Necroscopy*—The missile was found resting against the innominate artery, whose canal it had opened, causing a diffused aneurism. The aperture was oval, nearly half an inch in length, situated on the front part of the vessel, just below its bifurcation.³

By exploring the wound with a finger, in this case, the surgeon might have detected the orifice in the innominate artery, and by covering the

¹ Ibid., p. 94.

² Medical and Surgical History of the War of the Rebellion, First Surg. Vol., p. 520.

³ Ibid., pp. 520, 521.

orifice with this finger in the wound, he might have restrained the hemorrhage until the artery had been exposed and ligatured on each side of the aperture. The proceeding here recommended is exactly that which has many times been practised with complete success in wounds of the femoral and carotid arteries.

WOUNDS OF THE SUBCLAVIAN ARTERY.—The traumatic lesions of this artery are not always hopeless. During the late civil war, at least five cases required surgical treatment, and in one of them the left subclavian was successfully ligatured by a Confederate surgeon. The others survived the casualty from two to sixteen days.¹

In cases belonging to this category, the hemorrhage should, if possible, be restrained by digital compression, applied in the way just pointed out, until the artery can be tied above and below with carbolized catgut.

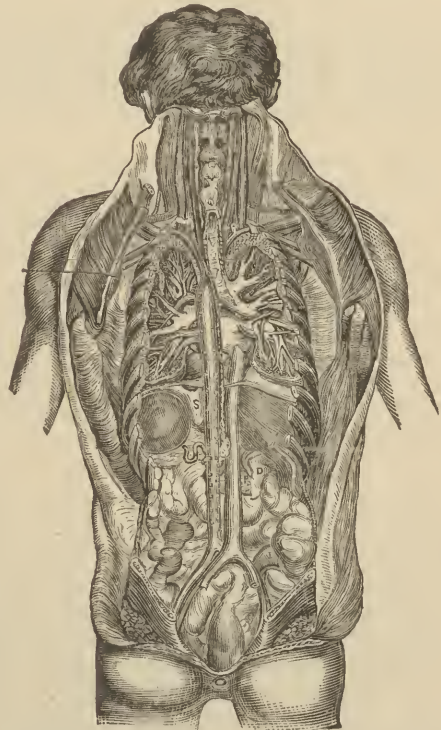
WOUNDS OF THE VENÆ CAVÆ.—In this class of injuries, death usually occurs so speedily from hemorrhage that examples of them are but rarely seen by surgeons during life. I will present a few illustrative cases:—

Fig. 434.

During the late civil war, a soldier received a shot-wound through the chest; “a great stream of blood is said to have gushed from his mouth as he fell forward, dead.” *Necroscopy*—The ball entered at the right edge of the sternum, between the first and second ribs; pierced the *descending cava*, one inch above the heart; struck the right bronchus, severing three rings (thus giving a ready exit to the large stream of blood); and emerged between the seventh and eighth ribs without wounding the lungs. There was a little clotted blood in the mediastinum under the sternum.²

In another case, death ensued not quite so rapidly:—

A soldier during the late civil war, through the stock of whose musket a conoidal ball had passed, was fatally wounded thereby. The missile entered his chest through the second right intercostal space, divided the *descending cava*, crossed the chest diagonally beneath the aorta, emerged through the third left intercostal space, shattered the left humerus, and was found thirteen feet from where the man fell, in a battered state. Externally there was scarcely any hemorrhage; but the left pleural cavity contained much bloody serum mixed with jelly-like clots. The hemorrhage was exclusively due to the division of the cava. The patient lived long enough to be carried from his post to the hospital, near by, where he immediately died. The missile also perforated the superior lobe of the left lung. The specimen is preserved in

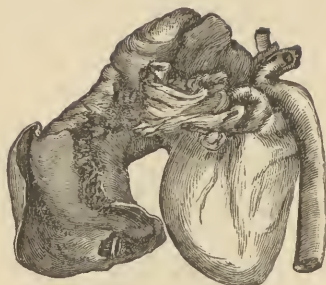


Showing from behind the relations of the aorta, venæ cavæ, heart, pulmonary artery and veins, etc., to the other viscera.

¹ Medical and Surgical History, etc., First Surgical Vol., p. 521.

² Ibid., p. 520.

Fig. 435.



Shot-wound dividing the descending aorta and perforating the left lung. Heart and great vessels also represented.

the Army Medical Museum, and is represented in the accompanying wood-cut, Fig. 435.¹

In the following example, the patient survived still longer:—

A soldier was wounded with arrows, and scalped by Indians, six miles from Fort Philip Kearney, D. T., September 26, 1866. The steel point of one arrow entered at the junction of the first (right) rib and the sternum, and penetrated downward and inward three inches, cutting the upper margin of the right lung, and making a wound in the *descending aorta* one-eighth of an inch long, just without the pericardial sac. Although scalped, and otherwise wounded, the unfortunate man survived until 10 A. M. on the 28th, over forty hours after the casualty. Large masses of coagula were found in the thoracic cavity.²

Wounds of the *ascending vena cava*, as a rule, also prove quickly fatal:—

A soldier, during the late civil war, was wounded February 24, 1862, and lived only a few minutes. The ball entered the right side of his thorax, fracturing the ninth rib near its angle, and wounding the lower border of the right lung. It then passed through the diaphragm, tearing open the liver, the ascending aorta, the stomach, etc. etc. The heart was found empty, while the cavities of the abdomen and thorax were entirely filled by the hemorrhage.³

The ascending aorta sometimes sustains a rupture from the operation of a comparatively trivial cause: Dr. Minor presented an illustrative specimen to the New York Pathological Society, November 28, 1855. It was taken from a woman in the fifth month of pregnancy, who, while dancing at a ball, suddenly fell to the floor and died.⁴

There are on record a few examples in which the abdominal bloodvessels were ruptured. Legouest's case I have already presented. Velpeau⁵ refers to three cases of rupture of the ascending aorta. Bourguignon⁶ cites another such case. A specimen of the vena cava ruptured by a blow is preserved in Guy's Hospital Museum. Professor Gross mentions a fatal case of laceration of the splenic vein recorded by Dr. Miling.⁷

WOUNDS OF THE VENA AZYGOS.—Hennen⁸ reports the case of a soldier injured by a twenty-four pound shot, which brushed along the right pectoral muscles without raising the skin or fracturing any bone, who died thirty-six hours afterward with all the symptoms of suffocation. *Necroscopy*—The vena azygos was found ruptured; also, the intercostal artery accompanying the fourth right rib; and two pounds of blood were found extravasated in the thoracic cavity. Blandin⁹ observed the case of a young man who survived a short time a pistol-shot wound of the vena azygos, near its terminal curve. Breschet¹⁰ records the autopsy of a man, aged 25, who survived for

¹ Specimen 5567, Sect. I., A. M. M.; Circular No. 3, S. G. O., 1871, p. 34.

² Circular No. 3, S. G. O., p. 146.

³ Medical and Surgical History, etc., Second Surgical Vol., pp. 138, 139.

⁴ Transactions of New York Pathological Society, vol. i. p. 99.

⁵ Dict. de Méd., etc., t. i.

⁶ Bull. de la Soc. Anat., t. xiii. p. 507.

⁷ System of Surgery, 5th ed., vol. ii. p. 687.

⁸ Military Surgery, p. 95, Am. ed.

⁹ Anatomie Topographique, p. 287.

¹⁰ Repertoire Gén. d'Anat., etc., t. iv. p. 196.

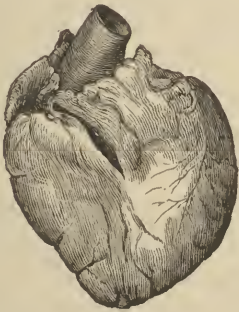
three days a punctured wound, received in a duel, of the azygos vein in the curve it describes before entering the cava.¹

WOUNDS OF THE PERICARDIUM.—The examples of this lesion which were reported during the late civil war tend to confirm the conclusions of Fischer—derived from the analysis of 51 cases with 22 recoveries—that wounds of this membrane, unless gravely complicated, are not as dangerous as has generally been supposed.² Two specimens preserved in the Army Medical Museum illustrate the subject, viz.: Specimen 504, a conoidal musket-ball imbedded between the arteria innominata and the descending cava within the pericardium, provoking pericarditis;³ and Specimen 2243, exhibiting shaggy deposits of lymph on the heart and pericardium, following gunshot injury.⁴ Eight cases with three recoveries are recorded with considerable minuteness of detail in the first surgical volume of the "History of the War" (pp. 528, 529).

WOUNDS OF THE HEART.—The traumatic lesions of the heart, though justly ranked among the most dangerous of all injuries, are not in every instance mortal.

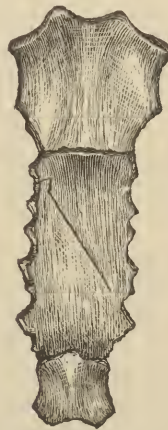
A man was killed⁵ in an affray at Fort Dodge June 2, 1867. He had inflicted, with a large sheath knife, several stabs upon his antagonist, when the latter, seizing his wrist, turned the point of the knife toward him, and suddenly drove the blade with great force into his chest, the handle being still grasped in his own hand. He fell at

Fig. 436.



The heart, showing the incised wound of the right auricle.
(Spec. 4870, sec. 1, A. M. M.)

Fig. 437.



The sternum, showing an oblique incision through it, which penetrated the right auricle of the heart. (Spec. 4869, sec. 1, A. M. M.)

once, gasping for breath, with his face deadly pale, and expired in about eight minutes. *Autopsy*—The knife-blade, after cutting cleanly through the sternum, had traversed the mediastinum, and freely opened the right auricle of the heart. The pericardium and the mediastinum were filled with extravasated blood, and the cardiac cavities were empty. The specimens are represented in the accompanying wood-cuts (Figs. 436 and 437).

¹ See Medical and Surgical History, etc., First Surgical Vol., p. 527. Foot-note.

² Ibid., p. 528.

³ Catalogue, p. 453.

⁴ Catalogue, p. 454.

⁵ Medical and Surgical History of the War of the Rebellion, First Surg. Vol., p. 534; Circular No. 3, S. G. O., 1871, p. 91.

The traumatic lesions of the heart consist of punctured and incised wounds; contusions, lacerations, and ruptures; and gunshot wounds. Formerly, punctured and incised wounds were most frequently met with; at present, however, the lesions from firearms are much more common. Of twenty cases which occurred in our army during a period of five years after the civil war, the patients in eighteen were wounded by firearms, and in two were stabbed with knives.

Death occurs instantaneously in some of the cases. But, in most instances, a brief interval elapses before life is extinguished. When severe blows on the chest from falls, or from the kicks of animals, or from spent shot or large fragments of shells, rupture the heart without external wound, death almost always occurs on the spot. M. Terrillon, however, in an article on traumatic rupture of the heart, has presented a case in which the heart was ruptured by a fall, and the patient lived four hours; also the case of a man whose heart was ruptured from being kicked in the chest by a horse, and knocked backward, who was able to get up, put on his hat, and walk toward the stable, falling dead on the way.¹

When, too, the heart is wounded by firearms, death does not always immediately follow. In the surgical history of the late civil war, four cases of this sort are recorded. In one of them the patient lived one hour and a quarter after a perforation of the right auricle and left ventricle by a conical pistol-ball; in another, the patient lived forty-six hours after a perforation of the left auricle and left ventricle by a pistol-ball, although the case was complicated by wounds of the abdomen and axilla; in still another instance the patient survived, for fourteen days, a wound of the right auricle made by a round musket-ball; and in the fourth example, the patient survived, for two and a half years, a gunshot wound of the right auricle.

This patient was a sharp-shooter, aged 42, who was wounded at Spottsylvania May 12, 1864, by a conoidal musket-ball, which entered his left breast and emerged from his left shoulder, passing completely through the left thorax, injuring the heart and left lung. On November 22, 1866, he very suddenly died. At the *autopsy*, the evidence of the original injury of the heart was found. On tracing the track of the ball a cicatrix was distinctly seen on the right auricle; softening and rupture of the muscular tissue of the auricle had resulted, with almost instantaneous death.²

An important specimen illustrating a pistol-shot wound passing through the pericardium, the right ventricle, and the septum, together with the semilunar valve next the septum, into the aorta, with apparent recovery, was shown to the New York Pathological Society:³—

A farm-hand, aged 18, was accidentally shot in the left breast July 7, 1878, with a small revolver (calibre $\frac{1}{20}$ inch). In less than a fortnight he was again at work, apparently well. He continued in good health, performing the ordinary labor of a farm-hand without inconvenience, until August 30, when he was found dead at his work behind a plough, fifty-four days after the accident. The *autopsy* showed that death had resulted from extravasation of blood into the pericardium and left pleura. The missile was found in the left ventricle, lying behind a columna carnea. The track of the ball was found to be as stated above. The explanation of the lodgment of the ball is, that it encountered a well-filled left auricle, and, being spent, it dropped down through the left auriculo-ventricular opening to the place where it was found. The wound through the right ventricle was valvular, and the pericardium, healing quickly here, prevented the escape of blood. This finally rupturing, from over-distension, death ensued. With

¹ Le Progrès Médical, Mars 29 et Avril 5, 1879; also American Journal of the Medical Sciences, October, 1879, pp. 566, 567.

² Medical and Surgical History of the War of the Rebellion, First Surg. Vol., pp. 530, 531.

³ Medical Record, December 14, 1878.

needful rest for a time, instead of labor, no reason appears why this young man should not have in reality recovered.

Velpéau mentions the history of a man who was stabbed in the left side. The symptoms which ensued were such that at the time the heart was supposed to have been pierced. Nine years afterward he died from other causes. The *autopsy* established the truth of the former diagnosis, as the cicatrix of the wound was found in the right auricle as well as in the pericardium.¹

Dr. George Fischer² has collected 452 cases of heart-wound, of which 380 ended in death, and 72 in recovery. Death was immediate in 104 cases, while in 270 it occurred after intervals varying from one hour to nine months. There were 44 punctured wounds with 10 recoveries; 260 punctured and incised wounds with 43 recoveries; 72 gunshot wounds with 12 recoveries; 76 contusions and traumatic ruptures with 7 recoveries. In 36, or exactly one-half of the 72 recoveries, the diagnoses were verified by post-mortem examinations held long after the original injuries; and this circumstance affords good ground for supposing that the remaining 36 cases were likewise correctly diagnosed. Fischer also notes the relative frequency with which different parts of the heart were wounded. In 123 cases it was the right ventricle; in 101, the left ventricle; in 28, the right auricle; in 13, the left auricle; and in 17, the apex of the organ. The right ventricle and the right auricle are wounded much oftener than the left ventricle and the left auricle, because they occupy by far the larger share of the front or the exposed portion of the heart; the statistics collected by M. Ollivier and by M. Jamain support Fischer's conclusions.

Additional examples of *recovery* from wounds of the heart, which have appeared during the last twelve years, may be found reported as follows:—

In the London Lancet³ a case is recorded of the removal of a needle from the heart on the ninth day, recovery ensuing. Dr. C. L. Ford⁴ reports a case of heart-wound from buck-shot, which was successfully treated. In the British and Foreign Medico-Chirurgical Review⁵ there is related a case of bullet-wound of the heart with recovery; on the twentieth day the external wound was already healed, and the cicatrix moved synchronously with the systole of the heart.

Additional examples of *long survival* after wounds of the heart, which have been noted during the last twelve years, may be found reported as follows:—

Mr. West,⁶ in an article on wounds of the heart, gives a summary of twenty cases. In one of them, the patient lived 19 years and 7 months after both ventricles had been wounded with a knife. Dr. P. S. Conner⁷ reports a case of gunshot wound of the heart, wherein both ventricles and the right auricle were involved, and yet the patient survived 3 years, 2 months and 13 days. Steudener,⁸ of Halle, is quoted as reporting a case of pistol-shot wound of the heart, with survival for 15 weeks. On autopsy, a cicatrix was found at the apex of the left ventricle, corresponding to the wound of the pericardium; grains of powder were also found embedded in the substance of the heart. Sir James Fayer⁹ mentions a case of bullet-wound of the heart, with survival for 72 days. The missile was found in the apex of the left ventricle. Tillaux is quoted¹⁰ as having exhibited at the Société de Chirurgie, the heart of a woman who had survived two gunshot wounds for 18 days, one missile lodging in the left ventricle of the heart. Dr. H. W. Boone¹¹ relates a case of gunshot heart-wound, with survival for 13 days. A case of stab-wound of the right ventricle of the heart is reported, in which the patient

¹ Traité d'Anat. Chirurg., t. i. p. 604, 2e éd.

² Archiv f. klin. Chir., Bd. ix. H. 2, S. 571. Berlin, 1868.

³ Lancet, 1873, vol. i. p. 272.

⁴ No. for July, 1876, p. 205.

⁵ St. Louis Clinical Record, 1876.

⁶ Lancet, 1879, vol. i. 658.

⁷ American Journal Med. Sciences, October, 1879, p. 509.

⁸ Medical Record, 1875, p. 173.

⁹ St. Thomas's Hospital Reports, 1870, p. 237.

¹⁰ London Medical Record, 1874, p. 212.

¹¹ Canada Lancet, 1876, p. 242.

lived 5 days.¹ Dr. G. F. Dudley² reports a case of pistol-ball in the heart, in which the patient lived 4 days.

Symptoms of Heart Wounds.—These are often very obscure. There may be present, in cases of wound which penetrate the region of the heart, great prostration of strength with swooning or syncope, a thready, weak, irregular pulse, a feeble and tumultuous action of the heart, precordial distress and anxiety, with dyspnoea and other signs of hemorrhage into the pericardial and pleural sacs, pallor, cold sweats, a husky voice and excessive thirst, together with a systolic bellows murmur or other abnormal sounds, without establishing anything more than a strong presumption that the heart itself is wounded. But, although the traumatic lesions of the heart are not attended by any symptoms that are peculiar to, or characteristic of them, the concurrence or coincidence of most of the phenomena just mentioned, in a case where the patient is wounded in the cardiac region, will render the diagnosis of a cardiac wound highly probable. According to Dr. Fischer's statistics, the phenomena which usually predominate in cases of sudden death from this lesion are those of sudden syncope or collapse; not unfrequently a hurried exclamation or a convulsive gasping occurs; but the popular notion that persons spring into the air when shot or stabbed through the heart, is not supported by the facts.

In the *causation of sudden death* from traumatic lesions of the heart, there are three important factors: (1) Shock; (2) Anæmia of the brain and lungs, directly caused by the escape of blood from the chambers of the heart: (3) Arrest of the cardiac movement by compression resulting from distension of the pericardium with extravasated blood. Oftentimes, in such cases, a *necroscopy* shows the heart firmly contracted and empty, with much extravasation of blood in the pericardial and pleural sacs.

Traumatic carditis is a very infrequent complication, if, indeed, it ever does occur. During the late civil war, enough examples of cardiac wounds in which the fatal issue was sufficiently delayed to afford time for the development of inflammatory phenomena, were observed, to warrant the conclusion that inflammation of the heart is as infrequently the result of injury, as of disease. The late Dr. Otis carefully examined two specimens from patients who had survived, for a fortnight or more, shot wounds grazing the heart, in which the pericardium was thickened, and the visceral as well as the reflected layer of the pericardium thickly coated with slaggy exudations; but the muscular structure presented no alterations discernible by the microscope.³ Professor Gross is possessed of a pericardium, taken from a man, aged 22, which contains an encysted needle two inches in length, giving evidence of having been long a harmless intruder. This specimen illustrates the indisposition of the parts to take on inflammatory action.

Treatment.—At first, the posture of the patient must be recumbent, with the head low, in order to avoid a fatal syncope from cerebral anæmia. External warmth should be applied to the extremities and along the spine. Opium or morphia should be administered to quiet alarm and restlessness, as well as to allay pain. In many cases the surgeon's hope must rest upon the continuance for some time of a condition approaching collapse, by which the power of the heart will be greatly lessened and the stability of a clot more assured. If signs of a dangerous reaction appear, the tincture of veratrum viride should be employed to restrain the heart's action (Agnew). Should life be prolonged, and inflammatory phenomena arise, reliance must be placed on blisters, opium, and cardiac sedatives; and should distension of the peri-

¹ St. Thomas's Hospital Reports, 1874, p. 420.

² Medical Record, 1871-2, p. 156.

³ Med. and Surg. History, etc., First Surg. Vol., p. 622.

cardial sac with inflammatory products cause much dyspnoea or cardiac embarrassment, they must be withdrawn by paracentesis. Absolute quietude of body and mind must be maintained for a long time, with liquid alimentation in concentrated and easily digestible forms.

WOUNDS OF THE PULMONARY ARTERY.—Traumatic lesions of this vessel almost always prove quickly fatal. But Timacus of Colberg records the case of a nobleman, stabbed through the right axilla, between the third and fourth ribs, the blade wounding the pulmonary artery. Frothy blood flowed externally, and there were frequent syncope; still the wounded man lived three days.¹

WOUNDS OF THE PULMONARY VEINS.—In the first surgical volume of the history of our civil war, at page 588, is recorded a case in which a conoidal ball penetrated the left chest, and lodged, on October 27, 1864:—

The patient suffered much from dyspnoea and frequent painful cough. He steadily grew worse, and died on November 11 of secondary hemorrhage from the left pulmonary vein. *Autopsy*—The missile, as shown in the accompanying wood-cuts (Figs. 438 and 439), was found lodged against the left pulmonary vein, which had been opened by it.

Fig. 438.



Showing the upper half of left lung with a conoidal ball embedded in its substance, and partially occluding the left pulmonary vein. (Spec. 3388, sec. 1, A. M. M.)

Fig. 439.



Showing the ball and a piece of lead removed from Spec. 3388.

Dr. Otis refers to Specimen 3388, A. M. M., represented above (Fig. 438), as suggesting a possible explanation of the way in which balls and other foreign bodies may gain admission to the cavities of the heart without leaving any trace of wound in the walls of that organ, viz., by gradual absorption of the wall of the pulmonary vein compressed by the extraneous body.² In the above case, the missile probably contused the tunics of the pulmonary vein, and thus laid the foundation for secondary hemorrhage to occur when the bruised tissue should separate by ulceration, and open the vessel.

WOUNDS OF THE MIDDLE MENINGEAL ARTERY.

This vessel, from its peculiar position and wide distribution, is much exposed to injury in simple as well as in compound fractures of the skull, and in the

¹ Ibid., p. 527. Foot-note.

² Ibid., p. 613.

common accidents of civil life as well as in the casualties produced by fire-arms and sabre-cuts in time of war. Furthermore, from the situation of this vessel and its branches in bony canals on the inner surface of the skull, there results, when it is torn across or severed, that the ends are held open by the surrounding structures, and that their expanded mouths cannot contract or retract; and for this reason spontaneous hæmostasis does not occur here, as it usually does in other parts of the body when arteries of a similar calibre are lacerated. Therefore, when the middle meningeal artery is wounded, the extravasated blood, if it cannot escape externally, collects between the dura mater and the bone, and compresses the brain; and the extravasation continues to go on, and the compression of the brain continually increases, until life is extinguished thereby. This is the reason why wounds of this small artery, in cases where there is no external vent for the extravasated blood afforded by the accident itself, or by the surgeon's art, always prove fatal. This inability for spontaneous hæmostasis to occur, is also the reason why the hemorrhage from this small artery, when it flows into an open wound, is often so persistent, and so difficult to suppress, that it demands the application of a ligature to the wounded vessel itself, or to the parent trunk, in order to save the patient from death by anæmic exhaustion.

The *symptoms* which hemorrhage from this artery causes when the blood is imprisoned within the skull, I shall not recite, for they are the symptoms of cerebral compression, and will be found set forth in full in the article on *Injuries of the Head*. What I have here to say is that, in such cases, the artery must be laid bare where it is wounded, in order to arrest the hemorrhage and avert its consequences, by performing the operation of trephining; and that, without the timely performance of this operation, there is no hope for the patient. If the application of one crown of a trephine does not bring the injured vessel into view, by reason of the clot covering it, or from any other cause, the instrument must be again applied over the normal track of the artery, either alongside the first perforation, or at the anterior inferior angle of the parietal bone; the search must be continued until the bleeding vessel is found, and when that is done it must be ligatured with carbolized catgut. The coagula must also be removed, and the wound must be treated antiseptically. If the symptoms of compression follow the injury very quickly, the inference, in the absence of other indications, is that the artery is wounded near the point where it enters the skull, that is, near the anterior inferior angle of the parietal bone, and there the trephine should be applied.

The middle meningeal artery is sometimes torn in cases of slight fissure of the inner table of the skull, when the outer table is uninjured. Such a case is the following:¹—

A boy, of strong, muscular build, was struck on the right temple by a cricket ball. The symptoms of cerebral compression ensued, and he died three and one-half hours after he received the blow. *Autopsy*—No bruise was found. On reflecting the scalp, however, a very scanty extravasation of blood was discovered under the right temporal aponeurosis. The external table of the skull was uninjured; but there was a slight crack which extended across the inner table. At this part, the middle meningeal artery ran in an osseous canal. A piece of bone was broken off, and the artery was torn completely across at this point. A clot, half the size of the fist, lay between the cranium and the dura mater, and the corresponding portion of the brain presented a distinctly bruised appearance.

The operation of trephining, seasonably performed, with antiseptic precautions and antiseptic after-treatment, would pretty certainly save such a patient;

¹ Edinburgh Medical Journal, vol. iii. p. 191.

and the case just related serves well to illustrate, in other respects, the soundness of the views above presented.

But compound fractures of the skull, especially when caused by fire-arms, are not unfrequently attended by *secondary hemorrhage from the middle meningeal artery*, which will prove fatal unless it is suppressed by the surgeon in a timely manner. What is the best plan of treatment?

In two cases of gunshot (shell) fracture of the skull involving also the middle meningeal artery, that were reported during the war of the Rebellion, in which the hemorrhage was uncontrollable by other means, it was permanently arrested by tying the common carotid artery. The following is a brief account of them:—

Private Wm. C. Andrews, Co. A, 30th Iowa Volunteers, aged 19, was wounded by a fragment of shell in the left temporal region, at Vicksburg, December 28, 1862. He was treated in a field hospital until January 17, 1863, when he was admitted to Lawson Hospital, St. Louis. On the 18th, hemorrhage amounting to twelve ounces occurred from the middle meningeal artery, and, all other means failing, was arrested by Dr. C. T. Alexander, U. S. Army, by tying the common carotid artery. The hemorrhage did not recur. The patient was discharged from the service on May 28. He was a pensioner in March, 1868, and the Pension Examiner reported that he had dizziness and faintness on exertion or stooping, and partial anæsthesia of the left side of the face, being compelled to keep his room in the cold winters of Madison, Iowa, from liability of the left ear and side of the face to be frozen. He continued in tolerable health on June 4, 1872, nearly ten years after the operation.¹

Sergt. Joseph Dougherty, Co. B, 69th New York Vols., aged 23, sustained a fracture of the right parietal bone by a shell, at Spottsylvania, May 13, 1864. He was brought to hospital at Alexandria. A fragment of bone was removed. Hemorrhage from the middle meningeal artery occurred, of such a character as to compel Dr. E. Bentley, U. S. Vols., to ligate the common carotid artery. "The hemorrhage did not recur; but the patient succumbed on the thirteenth day, after a series of chills and other phenomena of pyæmic infection."²

When we are sure that the hemorrhage proceeds from the middle meningeal artery, we should ligature the external carotid, of which the middle meningeal is a branch, instead of the common carotid artery; for the ligation of the former is much less likely to be followed by cerebral softening and other bad consequences, *per se*, than the ligation of the latter, while it is quite as likely to control the bleeding.

In cases of secondary hemorrhage from the middle meningeal artery, as well as in those of primary hemorrhage, the bleeding vessel should, if possible, be ligatured by the surgeon where it is injured. But when it is not feasible to do that, as will not unfrequently happen, while the wound is suppurating, the external carotid should be tied. Moreover, the performance of the operation should not be delayed from any expectation that because the artery is a small one, the bleeding can be stanchèd by minor procedures. Should, unhappily, the operation be deferred while the trial of compression and styptics is continued in such cases, the hemorrhage will continually recur as soon as the patient rallies from each successive bleeding, until finally he will become so much exhausted from loss of blood that the successful ligation of the external carotid will be impossible.

WOUNDS OF THE ABDOMINAL AND PELVIC BLOODVESSELS.

These wounds are extremely dangerous, and their great perilousness results from the hemorrhage—which usually is internal, and therefore concealed from

¹ Med. and Surg. Hist., etc., First Surg. Vol., p. 314.

² Ibid., pp. 255, 256.

view—by which they are attended. The dictum of Jourdan, that surgery is powerless in lesions of arteries within the cranial, thoracic, and abdominal cavities, should be expunged, because it is not true. If the surgeon, with cautious temerity, explore a penetrating wound of the abdomen or pelvis with his finger, he will not unfrequently discover that a hemorrhage which threatens life proceeds from a vessel which he can ligature above and below the wound with carbolized catgut; and thus he may save his patient from an otherwise certain death.

Extravasation of blood into the peritoneal cavity may proceed from wounds of the abdominal aorta and its branches; or from wounds of the ascending vena cava and its tributaries; or from lesions of the vena portalis and its ramifications; or from lacerations of the viscera, especially the liver and spleen.

The sudden occurrence of a copious extravasation of blood into the abdominal cavity is indicated by the sudden appearance of the well-known constitutional signs of hemorrhage, even without any external bleeding, in cases where wounds penetrate the abdominal cavity or involve the organs contained in it. These signs are pallor of the face, and of the surface generally, from bloodlessness; faintness; smallness, quickness, and feebleness of the pulse; cold sweats, etc. A slow, gradual bleeding into the abdominal cavity may, however, continue unsuspected to a dangerous or even to a fatal extent, so slight are the symptoms caused by it. For instance, Follin mentions a case in which death resulted from the puncture of a terminal ramification of the mesenteric artery by a bayonet, and in which the hemorrhage was not suspected until revealed by the autopsy.

The hemorrhage from a ruptured liver or spleen should be treated by placing the patient on the injured side and enforcing absolute immobility, by applying ice-poultices over the injured organ, and by freely administering gallic acid, with ergot, and with dilute sulphuric acid, to assuage thirst. To allay pain and quiet apprehension, opium or morphia must be exhibited. The same plan of treatment should be applied to all the hemorrhages which occur into the abdominal cavity without external wound, to those from ruptured veins and arteries, as well as to those from ruptured viscera. Moreover, phlebotomy must be rejected in all of them.

But in cases where there is an external wound which penetrates the abdomen, the possibility of restraining the hemorrhage by ligaturing the injured vessel must always be considered. It is a disgrace to modern surgery that patients should be allowed to die of internal hemorrhage, in cases of wounds penetrating the abdominal cavity from the front or the sides, without any effort being made to save them by cautiously exploring the wound with a finger, ascertaining through the sense of touch the source of the hemorrhage, and securing the bleeding vessel with carbolized catgut ligatures. Sometimes the blood flows inwardly into the peritoneal cavity, from a wounded artery belonging to the abdominal walls, such as the internal epigastric, instead of escaping externally. In such a case, the exploration of the wound with a finger may instantly reveal the source of the bleeding. And then the surgeon can make his patient secure without delay, by enlarging the wound so as to bring the injured vessel into view, and tying it on each side of the aperture with carbolized catgut. I have already dwelt upon the disastrous consequences of neglecting this paramount procedure. I also believe that operative interference should be carried in this direction to the utmost verge of the limits which prudence enjoins. Examples are not wanting in which branches of the mesenteric, epiploic, gastric, and colic arteries, have been successfully ligatured. If the finger, introduced into a wound penetrating the belly, recognizes the warm jet of a bleeding artery, the bleeding point must be exposed and securely tied. It would be more rational to ligature even the

vena cava or the aorta, than to stuff the wound with lint saturated with Monsel's solution, as has been done in more than one mortal hemorrhage. (Otis.)

When, therefore, the abdomen has been penetrated by a wound, and considerable bleeding takes place, it is necessary to search for the injured vessel. When it comes from one of the mesenteric arteries or from the epigastric, the wound should be enlarged until the bleeding artery is exposed, and then ligatures should be placed on both ends. (Guthrie.) To the dictum of Guthrie just presented, I would add that the vessel from which the deadly hemorrhage is issuing, whatever its name and rank may be, must be found, and ligatured above and below, if possible. Effusions of blood into the abdominal cavity which do not directly kill by syncope, may do so indirectly. When the quantity is large, the blood fails to become absorbed; it then decomposes, and causes death by inducing septicæmia or by exciting peritonitis. In penetrating wounds, therefore, after the hemorrhage has been suppressed by ligature, the extravasated blood should be evacuated as completely as possible, and antiseptic precautions should be employed.

Wounds of the *pelvic* bloodvessels have been but little studied. In civil as well as in military practice, the cases belonging to this group will sometimes present the most difficult as well as the gravest problems to the surgeon.

WOUNDS OF THE COMMON ILIAC ARTERY.—The first ligation of the common iliac artery, it will be remembered, was performed by Gibson, to suppress the hemorrhage from a shot-wound. Our Army Medical Museum contains a specimen in which the right common iliac artery is perforated by a pistol-ball. A wood-cut illustrating this specimen has already been presented. (Fig. 311, *supra*, p. 200.) The patient survived the casualty twelve minutes; and had a competent surgeon been at hand, the injured vessel might have been successfully tied on each side of the perforation, the main trunk meanwhile being firmly compressed, and the distal ligature first applied. Bogros, in Velpeau's presence, dissected a subject with a similar wound. Larrey¹ records a case of sword-puncture of the iliac vein and artery, treated apparently with success by provisional compression and the method of Val-salva. Such instances, however, are rare; but wounds of the branches of these vessels—of the gluteal, pudic, obturator, and sciatic arteries—often come under treatment, and their management requires the utmost discrimination.²

During the late civil war, hemorrhage was the most important complication in numerous cases of wounds penetrating the pelvis, and in many of them the precise source of the bleeding was not determined. It was not always decided even whether the bleeding vessels were branches of the external or of the internal iliac. In no region, too, was the application of the cardinal rule of ligaturing a wounded vessel above and below the lesion more difficult, and in none were the consequences of neglecting this rule more disastrous.³

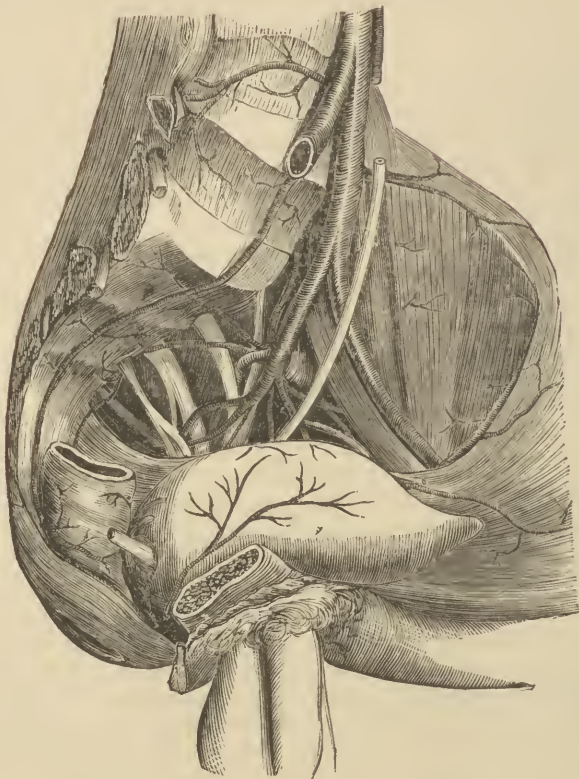
WOUNDS OF THE INTERNAL ILIAC ARTERY.—The primary lesions of this vessel, like those of the common iliac artery, but seldom receive surgical treatment, because death from hemorrhage too speedily ensues. A case, however, is reported in the history of the late civil war, in which this artery appears to have been wounded by a musket-ball, and the man was taken to a field-hospital, where he died from internal hemorrhage fifteen hours after

¹ Clinique Chirurgicale, 1829, t. iii. p. 156.

² Medical and Surgical History of the War of the Rebellion, Second Surg., Vol., p. 323.

³ Ibid., p. 325.

Fig. 440.



Showing the bloodvessels, nerves, and viscera of the pelvis.

the casualty.¹ Moreover, there are six cases of gunshot wound of the pelvis reported, in which *secondary hemorrhage* occurred from lesions of the internal iliac artery, between the twelfth and twenty-first days, and death ensued.² The tunics of the artery in each instance were probably bruised by the missile, and when the disintegrated tissue was separated from the sound tissue by ulceration, the artery was opened, and hemorrhage ensued. In three cases the internal iliac artery was ligatured on Hunter's plan to suppress the hemorrhage from a wounded branch, but without success in every instance.³

In the following case, the inferior hemorrhoidal arteries were wounded by a conoidal musket-ball, and death took place from secondary hemorrhage on the fortieth day:—

A soldier, aged 20, wounded May 8, 1862, in the buttocks and rectum, had hemorrhages several times which were checked by liquor ferri persulph. and opium, until June 16, when hemorrhage again occurred from the bowel, and he died in half an hour. *Necroscopy*—The ball entered the pelvis at the obturator foramen, passed directly through the rectum, broke off the spinous process of the ischium of the opposite side, and lodged in the fibres of the gluteus medius. The bleeding vessel was one of the inferior hemorrhoidal arteries; the space between the sacrum and rectum was filled with coagula; the recto-vesical fold was elevated, and its peritoneal surface was dark in color.⁴

¹ Ibid., p. 331.³ Ibid., pp. 332, 334.² Ibid., pp. 330, 331.⁴ Ibid., p. 326.

WOUNDS OF THE ILIAC VEINS.—A few cases were reported during the late civil war in which traumatic lesions of the pelvic veins were the most important complications. Wounds which open widely the common iliac vein or its two principal tributaries, as a rule, prove quickly mortal from the primary bleeding. There is, however, a case recorded, in which a conoidal musket-ball penetrated the pelvis through the right ischiatic notch, and divided the corresponding internal iliac vein, the man surviving more than twenty-four hours. On opening the abdominal cavity after death, it was found to be full of blood.¹ In cases where the external iliac vein is wounded, or the femoral vein near its entrance into the pelvic cavity, should the primary hemorrhage be suppressed, gangrene of the corresponding extremity does not of necessity ensue, as I have already shown in the section on wounds of veins.

The *symptoms* resulting from an intra-pelvic extravasation of blood, when the quantity is small or but moderate, may be obscure or almost wanting. Baudens, however, mentions, as a characteristic sign that a quantity of blood is being collected in the pelvis, the incessant and insupportable desire to micturate, which is caused by the pressure that is exerted on the bladder by the extravasation, and which is present although there is no urine in the viscus.

In some cases, important aid in diagnosing the lesions of the pelvic blood-vessels may be obtained by introducing the hand into the rectum, as has been practised in two instances by Professor H. B. Sands, of New York.² By manual exploration with the hand in the rectum, the condition of the lower part of the abdominal aorta, and of the common, internal, and external iliac arteries, can be satisfactorily ascertained. By the same means pressure can be directly applied to the common iliac artery as well as to the external and internal iliaes, so as to readily control the flow of blood through them, as Dr. Woodbury had already shown.³ The bowel should be evacuated by a large enema of warm water. The hand anointed with lard, and the fingers folded into a cone (the patient being anæsthetized), is gradually introduced into the rectum with its dorsum toward the sacrum, till it reaches the sigmoid flexure, when the hand may be pronated, and, as the vessels are directly under the fingers, they may then be examined or compressed at will. The sphincter recovers its tone in a few days, and, if the hand be slowly introduced, laceration is not apt to follow.

To suppress hemorrhage from the *external iliac vein*, when wounded, it will generally be necessary, as in cases where the femoral vein is wounded, to ligature the corresponding common femoral artery.

The mode of applying instrumental compression to the abdominal aorta, or the primitive iliaes, with Lister's or Erichsen's artery compressor, or Skey's or Pancoast's abdominal tourniquet, I have already pointed out (pp. 524, 577). Operative procedures should be pushed to the utmost bound of prudence when the pelvic arteries are wounded. In cases where gunshot missiles penetrate the pelvis, the liability to the occurrence of secondary hemorrhage from contusion of the internal iliac artery, or its branches, should always be remembered, and provided for as far as possible.

The timely application of instrumental pressure to the common iliac artery, together with the enforcement of absolute immobility of the patient, in cases of hemorrhage (whether primary or secondary) from wounds penetrating the pelvis, where ligatures cannot be applied, may possibly so restrain the bleeding that an occluding clot of a permanent character will plug the orifice, or that, at least, a traumatic aneurism amenable to treatment may result.

¹ Ibid., p. 190.

² Am. Journ. Med. Sciences, April, 1881, pp. 366-373.

³ Ibid., January, 1874.

TRAUMATIC ANEURISM.

DEFINITION.—A traumatic aneurism is a tumor filled with blood poured out from, and communicating with, the canal of a wounded artery. Between traumatic and spontaneous aneurisms there is another important distinction: namely, that in the former there usually exists before the accident a sound condition of the injured vessel, whereas, in the latter, the arterial tunics are diseased.

ETIOLOGY.—Traumatic aneurisms are caused by punctured, contused, lacerated, gunshot, and incised wounds of arteries, and I have already presented many examples of them in the foregoing pages, while discussing the several kinds of arterial wound.

VARIETIES.—Of traumatic aneurisms, two varieties are recognized: (1) the *diffused*; (2) the *circumscribed*. Each variety may, and often does, exist without an external wound.

I. DIFFUSED TRAUMATIC ANEURISM.—The *diffused* variety occurs immediately after the puncture, rupture, or division of an artery when there is no external wound; or, if there is an external wound, when it is valvular, or perchance closed in some other way, so that the blood cannot outwardly escape. Thus, the *diffused* variety of traumatic aneurism consists of an extravasation of blood into the connective tissue of the part. It is, in reality, not an aneurism at all, but a wounded artery with internal or concealed hemorrhage, instead of external bleeding. The tendency of a diffused aneurism is to constantly extend itself, or to expand by stretching and separating the anatomical components of the part wherein it is situated, and filling the space with soft coagula, until it bursts open from the mechanical distension of the part; or until inflammation, abscess, or sloughing takes place, when, an external opening being formed, the patient will perish from hemorrhage, unless the surgeon by timely interference stop the bleeding. If left to themselves, these tumors never undergo spontaneous cure.

Symptoms.—The diffused variety of traumatic aneurism is a subcutaneous, soft, and fluctuating tumor, often of considerable size, containing extravasated blood, and rising up or appearing immediately or very soon after the wounding of an artery. At first the skin covering it is not affected; but in a few days it frequently becomes discolored with ecchymoses, caused by the infiltration of blood. If the aperture in the artery be large and free, the tumor will exhibit pulsation, synchronous with the heart-beat, accompanied by a thrilling, purring, or jarring sensation, and often by a loud bruit. If, however, the injured artery be small, or if the aperture in the arterial tunics be oblique, or of a limited size, or obstructed, there will be no distinct pulsation or bruit; in such cases, the tumor will be indolent and semi-fluctuating, or will, perhaps, exhibit an impulse which is communicated to it by the subjacent artery. In the section on lacerated wounds and ruptures of arteries, I have presented many examples of diffused traumatic aneurism in which there was neither pulsation, nor thrill, nor bruit. The size of an aneurism of this variety will, in great measure, be determined by its locality. For instance, in the armpit, where the subcutaneous connective tissue is very loose, or at the root of the neck, or in the thigh, it may rapidly attain a very great bulk; whereas, in the palm of the hand, or at the bend of the elbow, in consequence of the strength and resistance of the fasciæ, its growth is correspondingly restricted. When the blood is suddenly effused in great quantity,

in a traumatic aneurism of the axillary or femoral region, all the constitutional signs of hemorrhage—pallor, cold sweating, pulselessness, and syncope—may arise; and sometimes, in such cases, death from anæmic exhaustion, as well as from syncope, may ensue. Of this I have already presented a number of illustrative cases.

Treatment.—Diffused traumatic aneurisms require the same treatment as wounded arteries, which has already been minutely set forth in the foregoing pages. Erichsen well observes:—

The treatment of these cases must be conducted on precisely the same plan as that of an injured artery communicating with an external wound, the only difference being, that, in the case of the diffused traumatic aneurism, the aperture in the artery opens into an extravasation of blood, instead of upon the surface. We must especially be upon our guard not to be led away by the term *aneurism* that has been applied to these cases, and not to treat such a condition, resulting from wound, by the means that we employ with success in the management of that disease.¹

The safety of the patient generally depends upon exposing the injured artery, and ligaturing it above and below the lesion. In deeply-seated arteries, *e. g.*, the gluteal in the buttock, or the posterior tibial in the calf of the leg, this is not always an easy operation. In some cases, however, compression with absolute quietude of the injured part should be tried before resorting to ligation. When arteries are ruptured by fragments of bone in simple fractures of the leg or thigh, compression, digital or instrumental, continuous or intermittent, should be applied to the main trunk of the femoral artery. This, together with the immobility of the injured limb and the moderate degree of pressure on the tumefaction which are furnished by the dressings of the fracture, has proved much more successful in such cases than any other plan of treatment, as I have already shown in the section on lacerated wounds and ruptures of arteries. So, too, in cases where the axillary artery is ruptured in reducing old dislocations, and a diffused aneurism forms in consequence thereof, compression should be applied to the subclavian artery over the first rib by means of a door-key, while the arm is immovably fastened to the chest by a roller, as I have already pointed out in the same section. Should compression fail in either class of cases, deligation of the main artery on the plan of Hunter will generally succeed, provided the arm be kept immovably fixed to the chest in one class of cases, or the leg be held motionless by the fracture dressings in the other. But, in cases where immobility of the injured part cannot be secured, the wounded artery should be laid bare and ligatured above and below the lesion, that is, the “old operation” for aneurism should be performed without delay. When an aneurism upon which the “old operation” is about to be performed is so situated that the circulation in the main artery cannot be controlled by digital compression, nor by a tourniquet, nor by Esmarch’s elastic ligature—as, for example, at the root of the neck—the surgeon should commence the operation by making a puncture just large enough to admit one or two fingers of his left hand, which he should quickly thrust into the swelling in such a manner as to plug up the orifice in the integuments; with a finger he should then search the bottom of the cavity, and find the aperture in the wounded artery, be it primitive carotid or subclavian; and with a finger or fingers he should cover the aperture in the wounded artery so as to prevent any outflow of blood from it while he lays the tumor freely open, removes the coagula, and ligatures the artery on each side of the lesion, as was done in the following instance, during the late civil war:—

¹ Science and Art of Surgery, vol. i. p. 162.

A soldier, aged 23, was wounded in the right side of the neck, at Antietam, September 17, 1862, by a buckshot which hit the common carotid artery. A diffused traumatic aneurism ensued. On the 30th, the tumefaction, already enormous, was rapidly increasing; it crowded the trachea considerably to the left side. The covering of the aneurism was tense, and pulsation with a hard thrill was perceived on palpation. A plug of lint held firmly by clotted blood filled up the wound. Dr. R. F. Weir, U. S. Army, having carefully assigned their duties to his assistants, withdrew the plug, and quickly enlarged the wound with probe-pointed instruments, sufficiently to admit two of his fingers to the bottom of the cavity. He "was so fortunate as to reach and compress the opening in the artery with very little difficulty, and thus effectually control the hemorrhage. Throughout the whole of the operation it was noticed with what ease the bleeding from the artery was checked—so little pressure was required. The clots were turned out, and the incision prolonged downward to the clavicle, and upward about one inch—the length of the entire incision being three and one-fourth to four inches." Ligatures were passed around the artery with Mott's aneurism needle (Fig. 441), below and above the aperture, "which the end of the fore-finger neatly

Fig. 441.



Mott's aneurism needle.

closed." Less than eight ounces of blood were lost during the operation. Death, however, ensued, from a gunshot lesion of the spinal cord, and from cerebral softening. Nevertheless, the case very clearly shows the entire feasibility of this operation for diffused traumatic aneurisms at the root of the neck.¹

The wound after the "old operation" for aneurism cannot be healed like an ordinary incised wound, but must be left to granulate; and great attention must be paid to the dressing. Having cut off the ends of the carbolized cat-gut ligatures close to the knots, and carefully washed out the cavity with a solution of potassium permanganate or of boracic acid, and afterward well sprayed it with carbolic acid, a drainage-tube should be introduced; and over all should be placed some carbolized lint or very soft oakum. As soon as suppuration begins, the wound must be dressed antiseptically every night and morning. The constitutional state of the patient must be provided for by administering nutrients, stimulants, and tonics.

II. CIRCUMSCRIBED TRAUMATIC ANEURISM.—This variety of aneurism does not, as a rule, present itself until some time after the injury that causes it occurs. In it, the blood that escapes from the canal of the injured artery is inclosed by a distinctly formed sac, which, in one large class of instances, consists of the external coat together with the sheath of the injured artery, and, in another large class, of laminae of connective tissue condensed by the expansion-pressure, and by the products of inflammatory irritation.

The accompanying wood-cut (Fig. 442) illustrates the first-mentioned class:—

It represents a preparation belonging to our Army Medical Museum,² of a circumscribed aneurism of the superior mesenteric artery, in which the sac consists of the outer tunic and the sheath. The inner and middle coats of the artery have burst; and,

¹ Med. and Surg. History, etc., First Surg. Vol., pp. 456, 457.

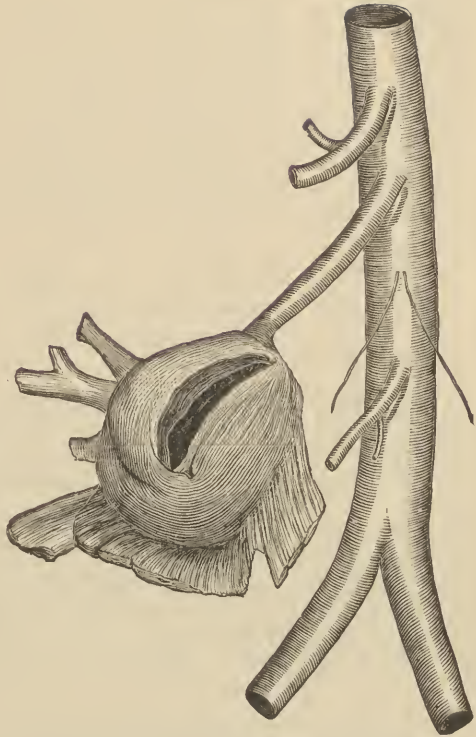
² Specimen 503, Sect. II.

inasmuch as no atheromatous change is discernible in them, and nothing appears to account for a spontaneous rupture, it is believed that they were lacerated by some traumatic cause. The tumor was recognized by its position and pulsation during the life of the patient, who died of another disease; but the antecedent history is, unfortunately, not recorded.¹ This sort of circumscribed traumatic aneurism is often produced by blows and strains; and I have presented a considerable number of examples of it in the foregoing pages. The inner and middle coats of the injured artery, on being torn through in this manner, gape open, and the pressure of the blood-stream expands the outer tunic and the sheath into an aneurismal tumor.

The other frequent sort of circumscribed traumatic aneurism is illustrated by the following woodcut (Fig. 443):—

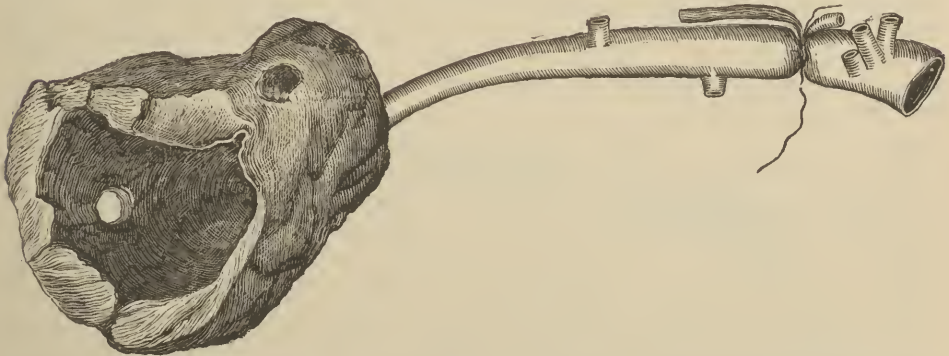
It also represents a preparation belonging to our Army Medical Museum,² which was obtained from the following case: A soldier, aged 28, received a shot-wound through the right shoulder and walls of the upper part of the thorax, implicating also the axillary artery,

Fig. 442.



Circumscribed traumatic aneurism of the superior mesenteric artery.

Fig. 443.



Circumscribed traumatic aneurism of the right axillary artery; ligature of the subclavian performed too late.

on June 9, 1863. The external wound appears to have healed without any trouble. Internally, however, an aneurism was developed from the wounded axillary artery in the latter part of the following month (July). On the 28th of that month, "the true nature of the disease became manifest," on making a careful examination, "as the pulsation of the tumor—at that time about the size of a large horse-chestnut—was very apparent; and, upon auscultation, the aneurismal bruit could be distinctly heard, cor-

¹ Med. and Surg. Hist. of the War of the Rebellion, Second Surg. Vol., p. 25.

² Spec. 2609, Sect. I.

responding with the contractions of the left ventricle of the heart." The treatment by compression was tried in vain. By August 16, the tumor had become much larger, and now caused great pain. It was decided to ligature the subclavian artery; but, early the next morning the aneurism broke, and discharged from thirty to forty ounces of blood. The operation was performed, but death occurred six hours afterward, in consequence of the previous loss of blood.¹ In this case the external wound healed, but the injured tunics of the axillary artery, which doubtless were texturally disorganized by the graze or bruise caused by the impact of the missile, slowly gave way, and, as they yielded, the extravasation of blood was restrained by laminae of connective tissue thickened by the products of inflammatory irritation, which ultimately formed the aneurismal sac.

Besides these, which are the common forms of circumscribed traumatic aneurism, two others are occasionally met with. One of them is *hernial aneurism*, an excellent example of which is reported in the *American Journal of the Medical Sciences*.²

In this case a small slice had been accidentally cut off from the sheath and outer tunic of the brachial artery, about two and one-half inches above the place of its division in an amputation of the arm. Secondary hemorrhage of an alarming character occurred from the stump, a consultation was held, aneurism of the brachial artery was diagnosed, and reamputation was recommended and performed. Examination of the reamputated portion showed a hernial aneurism of the brachial artery about two and a half inches above the ligature, where a small piece of the external coat had been shaved off by the amputating knife. Through this opening or ring, one-eighth of an inch in diameter, the inner and middle coats of the artery protruded, forming an aneurismal tumor, at least half an inch in diameter, and reminding one of the protrusion of a femoral hernia through its ring. The secondary bleeding had issued from a rent in the walls of this aneurism. Afterward the case did well.

In the second of these two rare forms of circumscribed traumatic aneurism, all the arterial tunics have been perforated, but the sac consists only of the external tunic and the sheath. It usually arises from a small puncture of a large artery, such as the axillary or the femoral. At first, the bleeding is profuse, but, being stopped by local compression, the external wound and the wound of the artery both heal up. Afterward the arterial cicatrix gradually yields, forming, at the end of weeks and months, a tumor which pulsates excentrically, with distinct bruit and thrill, and presents all the symptoms that characterize an aneurism from disease. The sac, too, is quite distinct, being formed by dilatation of the cicatrix in the sheath and external coat of the artery, without any blood being effused into the surrounding tissues. (Erichsen.)

Symptoms.—The circumscribed variety of traumatic aneurism is usually of less magnitude than the diffused, while it is much more tense and sharply defined. It pulsates excentrically, and exhibits the aneurismal bruit and thrill. It grows soft on compressing the parent trunk, and its pulsation, bruit, and thrill cease, to return again on discontinuing the pressure.

Treatment.—At first compression should always be tried, and, should it fail, ligation must be resorted to. In treating circumscribed aneurisms, traumatic as well as spontaneous, ligatures have been applied according to the plans of Anel, Hunter, and Brasdor; as well as according to the method of Antyllus, which is the "old operation."

On July 14, 1863, I ligatured the left subclavian artery, on Hunter's plan, for circumscribed traumatic aneurism, in a Confederate captain, aged 31, who, on June 21, had been shot through the left shoulder by a conoidal carbine-ball which severed the axillary artery. The bleeding ceased spontaneously, the wound healed kindly, and the

¹ Med. and Surg. History of the War of the Rebellion, First Surg. Vol., p. 545.

² No. for October, 1865, pp. 417, 418.

Fig. 444.

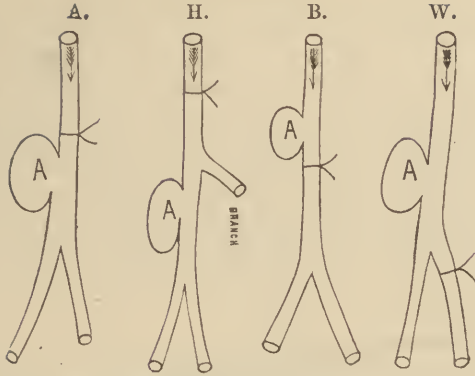
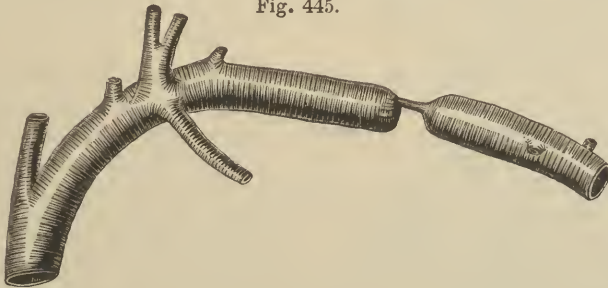


Diagram showing where the ligature is applied in Anel's, Hunter's, Brasdor's, and Wardrop's operations. (A.) In Anel's operation the ligature is applied to the artery on the cardiac side of the lesion, but between it and the first collateral branch. (H.) In Hunter's operation the ligature is applied to the main trunk on the cardiac side of the lesion, at a point much further from the lesion, and above the first collateral branch. (B.) In Brasdor's operation the ligature is applied to the main trunk on the distal side of the lesion. (W.) In Wardrop's modification of Brasdor's operation, the ligature is applied to a branch on the distal side of the lesion.

lesion of the artery gave no trouble until July 12, when a circumscribed traumatic aneurism as large as a pullet's egg was discovered. Between the 12th and 14th the tumor grew so rapidly that I feared to experiment with compression, lest meanwhile a rupture of the sac might ensue. It was so distinctly circumscribed, and resembled a spontaneous aneurism so closely in look and feel, that I thought Hunter's operation would almost certainly succeed, and accordingly I performed it. The wound made by the operation did well, and the ligature came away on the eighteenth day. Not so, however, with the aneurism; for on July 19 the sac suppurated, and discharged its contents through the anterior orifice made by the missile. The flow of purulent matter from the sac continued. On August 6, a violent secondary hemorrhage occurred, and several times recurred, until the patient died, on the 29th, worn out by the suppuration and the loss of blood. *Autopsy*—The distal end of the artery was found closed. The proximal end was found open, and from it the secondary hemorrhage had issued, the blood being derived from a reflux through the axillary branches into the axillary

Fig. 445.



Ligation of the left subclavian artery for circumscribed traumatic aneurism of the axillary; failure from secondary hemorrhage occurring in the wound.

trunk, and so through its open mouth, on the establishment of a collateral circulation. The only operation which could have prevented this mishap was the old one. The artery is preserved as a preparation in our Army Medical Museum.¹ It is also represented in the accompanying wood-cut (Fig. 445). In all cases like this, the "old operation" will afford a much better chance of saving the patient than the operation of Hunter or of Anel. The best method of performing the "old operation" in the arm-

¹ Spec. 1684, Sect. I.

pit I have already described with minuteness, while describing the lacerated wounds and ruptures of the axillary artery (p. 610). It is unnecessary to repeat it here.

On July 16, 1863, I was brought as consultant to the Post Hospital at Camp Barry, to see an immense pouch-shaped, though circumscribed, traumatic aneurism of the left femoral artery, in a soldier, aged 26, who had been wounded in the left thigh on May 26, by a pistol-ball, which grazed the femoral artery. The aneurism had already been treated by compression without benefit. So illy satisfied was I with the operation of Hunter in the case just related, that I imperatively insisted on the performance of the "old operation" in this case, and I also aided in its execution. The extent of the aneurismal tumor and the method of performing the operation are well shown by the accompanying diagram (Fig. 446). The aneurism extended from about two inches below

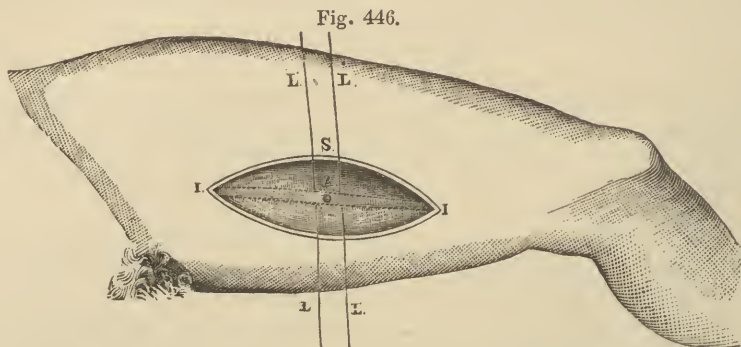


Diagram illustrating the length and course of the incision, the aperture in the artery, and the site of the ligatures, in a case of immense pouch-shaped circumscribed traumatic aneurism, which was treated successfully by the "old operation."

A, The aperture in the artery. II, The incision. LL, LL, Ligatures placed above and below the aperture.

Poupart's ligament down to within four inches of the knee-joint. The femoral artery was compressed digitally on the os pubis during the operation. The tumor was opened by an incision about eight inches in length. The sac was quite smooth internally, and contained but little coagulum. The aperture in the artery was small and oval-shaped. The blood that flowed from the distal part of the artery was venous-hued and without jets. No unpleasant symptoms whatever followed. The patient began light duty seven weeks after the operation, and soon was as well as ever. The scar of the wound of operation measured six and one-half inches in length.¹

When secondary hemorrhage occurs after the "old operation" for aneurism, the blood usually issues from the distal orifice because it has been insecurely tied. In such a case the wound should be reopened, and the ligature should be reapplied without delay. Thus Mr. Joseph Bell, in a case where he had performed the "old operation" for traumatic axillary aneurism, on the occurrence of secondary hemorrhage from the distal end of the artery, laid the wound open and tied the end again. The patient recovered.²

Many instances are related in the surgical history of the late civil war, in which the "old operation" for traumatic aneurism proved successful; and many instances, also, in which there was failure because other plans of operating were employed.

Esmarch's elastic ligature and elastic bandage are capable of affording great assistance in performing the "old operation" for traumatic aneurism in the extremities, both upper and lower. By a judicious application of these devices, this procedure can generally be executed with but little or no loss of blood.

¹ The histories of this and of the preceding case are reported at length by the author in the U. S. Sanitary Commission Surgical Memoirs, vol. i. pp. 101-120. New York, 1870.

² British Medical Journal, Feb. 22, 1879, p. 289.

Palmar aneurisms are best treated by applying Esmarch's apparatus, laying the tumor freely open under ether, turning out the clots, bringing into view the ends of the wounded artery, and tying them with carbolized catgut, without any loss of blood.

Traumatic aneurisms of the *vertebral artery* are not very uncommon. Kocher has collected twenty-one cases. No instance of spontaneous aneurism of this artery is on record. For vertebral aneurisms the treatment by compression must be tried. Should the tumor burst, or appear likely to burst, it should be freely opened with suitable precautions, and an effort should be made to tie the artery above and below; or, that failing, the artery must be cautiously plugged above and below with prepared agaric or some similar substance.

In examining traumatic aneurisms of the pelvis for therapeutic, as well as for diagnostic purposes, important information may sometimes be obtained by exploring the pelvic cavity with a hand introduced within the rectum, as I have already pointed out in the section on Wounds of the Pelvic Blood-vessels.

ARTERIO-VEINUS WOUNDS; ANEURISMAL VARIX AND VARICOSE ANEURISM.

Several examples have already been presented, in which the vulnerating body simultaneously opened a large artery and its accompanying vein, thus producing an arterio-venous wound. The following abstract, with the accompanying diagram, represents another case, which was reported by Dr. David Prince:—

A soldier, aged about 20, accidentally shot himself with a small pistol, October 21, 1864. The missile entered the left side of his neck, an inch from the median line, and on a level with the pomum Adami; it passed almost through, and lodged under the integuments just below the left occiput. The bleeding ceased spontaneously, and a considerable swelling formed. Oct. 28, a very distinct thrill was felt, and a loud whizzing murmur was heard in the tumor. Oct. 29, the wound having bled slightly in the night, the common carotid was ligatured below the omo-hyoid. Nov. 3, at 3 A. M., the patient died of cerebral softening or anæmic gangrene of the brain. *Autopsy*—The common carotid artery was found notched, and the internal jugular vein perforated, as shown in the accompanying wood-cut (Fig. 447). No distinct aneurismal sac had formed, and no embolism of the cerebral arteries had occurred.¹

Fig. 447.

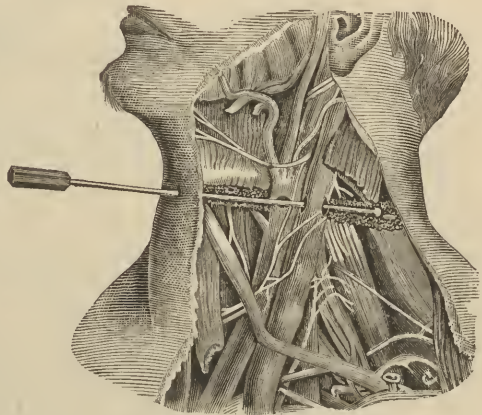


Diagram to illustrate an arterio-venous wound of the neck.

But wounds which simultaneously open the carotid artery and internal jugular vein, as well as wounds which open other large arteries and their attendant veins, do not always prove fatal; for, if their extent be small, and the circumstances otherwise favorable, they may result in forming aneurismal

¹ U. S. Sanitary Commission Surgical Memoirs, vol. i. pp. 146-148. New York, 1870.

varices or varicose aneurisms. When the lips of the wound in the artery adhere closely to the lips of the wound in the vein, and the blood flows from the artery directly into the vein, *aneurismal varix* results; but when the lips of the wound in the artery adhere less closely to the lips of the wound in the vein, and the pressure of the arterial current separates the wall of the artery from the wall of the vein, and the blood, by condensing before it the lamina of fascia and connective tissue at the wound, forms a pouch or sac lying between the two vessels, *varicose aneurism* results. The prognosis in a case of aneurismal varix or varicose aneurism is much less serious than it is when the artery alone has been opened; for a portion of the arterial blood is projected into the vein at each pulsation, and thus the pressure or strain upon the injured parts is considerably lessened. Thus, too, the occurrence of great swelling and of rupture is usually avoided.

ANEURISMAL VARIX.—By this term is meant an enlarged and tortuous, or varicose, condition of a vein, resulting from a simultaneous wounding of the vein and its contiguous artery, whereby a communication between the two vessels is established. The arterial blood which is projected into the vein at each pulse-beat, dilates it more or less extensively, and causes its wall to thicken.

Dr. William Hunter first described this lesion.¹ Scarpa, however, claims that Guattani should equally share the merit of the discovery, because he

Fig. 448.

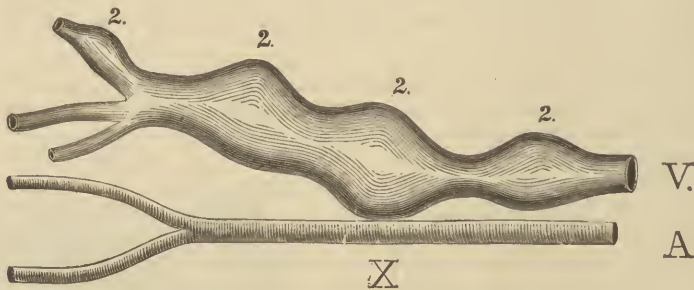


Diagram illustrating aneurismal varix. A, The artery. V, The vein. X, Site of the aperture of communication between the artery and vein. 2, 2, 2, 2, Varicose enlargements of the vein, with thickening of its walls.

published two undoubted cases of aneurismal varix.² But, Dr. Hunter's observations on this disorder were published in the years 1757 and 1764; while Guattani did not see his first patient until the year 1769, and his book was not published until the year 1772. An instance of this disorder had previously been mentioned by Semertus.

Symptoms.—With the history of a previous wound, aneurismal varix is characterized by a circumscribed tumefaction, usually small and bluish in color, formed by a dilated vein, possessing a peculiar tremulous motion, and attended with a peculiar thrilling, hissing, or buzzing noise which arises from the passage of blood through a small aperture in the artery into the dilated vein. This peculiar sound is sometimes said to be like that made by a fly on a pane of glass, or in a paper bag. The tumor is generally accompanied by a varicose state of the neighboring veins. It is soft, and disappears entirely under direct pressure. It subsides when the limb is elevated so as

¹ Medical Observations and Inquiries, vol. i. p. 340; and vol. ii. p. 390.

² Treatise on Aneurism, Wishart's translation, p. 190.

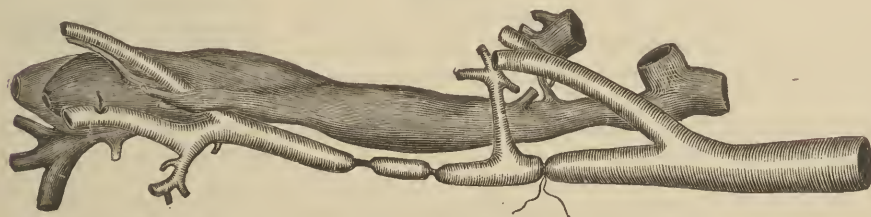
to favor the return of venous blood toward the heart, and, in the same way, its pulsation is lessened. But, when the limb hangs down, or pressure is applied to the vein on the cardiac side of the tumor, it enlarges or forms a more considerable swelling. Compressing the vein on the distal side of the tumor does not lessen either its size or its pulsation. When, however, the artery is compressed on the cardiac side of the tumor, the pulsation immediately ceases, and it instantly returns on raising the compression. The trunk of the artery, after a time, becomes considerably enlarged; and it pulsates more strongly than the corresponding vessel in the other limb. But, on the distal side of the tumor, the arteries get smaller and pulsate less strongly than they do in the corresponding part of the other limb. The sounds can often be heard in the veins at a considerable distance.

Aneurismal varix usually progresses but very slowly. There are cases on record in which no increase was observed for 18, 20, and even 35 years. When, however, the varicosities do enlarge, much evil may ensue from the pressure exerted by them. The obstruction to the venous circulation will cause œdema and cyanosis of the affected limb, and a lowered temperature, with ulceration or sloughing of the varicosities themselves, followed by hemorrhage, and sometimes by gangrene.

The following example was reported during the late civil war; it will serve to illustrate the symptoms and progress of this lesion:—

The patient was a soldier, aged 24. When a youth of 16, he was accidentally wounded with a pocket-knife, at the inner part of the left thigh, about two inches below Poupart's ligament, the blade puncturing the femoral artery and vein near the origin of the profunda. Profuse hemorrhage ensued, but it was arrested by compression; the wound healed, and in a week the patient went to work again as a farmer. Afterward he had no trouble, except sometimes a slight pain in the track of the wound after unusual exertion, until August, 1863, eight years after the accident, when, being now in the army, his limb suddenly swelled, in consequence of hardship and a long, fatiguing march, so as to measure thirty-two inches in circumference. On

Fig. 449.



Aneurismal varix of left thigh. Terminal portion of aorta and both iliac arteries also shown, with a ligature in position on the left one. (Spec. 3597, A. M. M.)

November 12, he entered the military hospital at Newark, N. J. The left thigh was much swollen, with œdema and varicosities, and presented a cyanosed appearance; an aneurismal thrill and bruit were also observed. On February 6, 1864, the external iliac artery was ligatured, but without benefit. In the following summer, the thigh became enormously distended, and a number of openings which had formed in it put on a gangrenous appearance. At the end of August the thigh measured thirty-seven inches in circumference, and its veins appeared more distended than before the operation. On September 17 the common iliac artery was ligatured, and on the fifth day afterward the patient died of peritonitis. A preparation was made of the vessels involved, which is preserved in our Army Medical Museum.¹ It is represented in the wood-cut above (Fig. 449). The ligature on the common iliac is shown

¹ Spec. 3597.

in situ. A constriction shows where the external iliac had been tied. The femoral artery appears constricted from imperfect injection. The much expanded and varicose condition of the femoral vein is well exhibited.¹ The œdematous and cyanotic tumefaction, with gangrenous ulcerations, which the aneurismal varicosities produced in this case, was well marked. The failure of the operations of Anel and Hunter to afford relief was also quite conspicuous.

VARICOSE ANEURISM.—By this term is meant a circumscribed traumatic aneurism which communicates on one of its sides with the artery from which it springs, and, on the opposite side, with an aneurismal varix. This lesion is well illustrated by the accompanying wood-cut (Fig. 450).

Fig. 450.



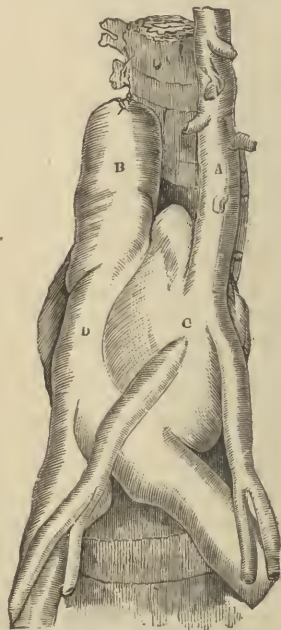
A varicose aneurism; the sac lies between the brachial artery and the median basilic vein, and communicates with both. (After Sir C. Bell.)

A, the brachial artery; V, the median basilic vein with an aneurismal varicosity; N, the aneurismal tumor, which is connected with the artery beneath it by a minute aperture, and with the aneurismal varicosity above it by another small opening.

The *symptoms* of varicose aneurism are those of aneurismal varix, just presented above, together with the symptoms of circumscribed traumatic aneurism. On expelling the blood from the varicosity by applying direct pressure, the aneurismal tumor still remains. In some very rare instances varicose aneurism has had a spontaneous origin. (See Fig. 451.)

LOCALITIES OF ARTERIO-VEINUS ANEURISM.—Arterio-venous aneurisms have most frequently been met with at the bend of the elbow, where they have arisen from punctures during venesection. M. Goupil states that in thirty-one out of fifty-seven cases the lesion was caused in this way. Dr. S. W. Gross has collected ten examples in which arterio-venous aneurisms occurred in the neck; in eight there was aneurismal varix, and in two, varicose aneurism. In all of them the internal jugular vein was involved, together with the primitive carotid artery in six instances, and the internal carotid in the remaining four. In none did the lesion appear to shorten life or cause much inconvenience. The lesion was caused by incised or punctured wounds in seven, and by gunshot wounds in three instances. In several of them the aperture in the integuments was so made that it did not gape when the

Fig. 451.



A remarkable varicose aneurism involving the aorta at its bifurcation, and the vena cava (Syme). A, Aorta; B, Vena cava ascendens; C, Aneurism; D, Site of a round aperture, somewhat larger than a sixpence, through which communication between the vessels was held. (Bennett's Lectures, p. 217, Am. ed.) Aneurism supposed to be spontaneous.

¹ Medical and Surgical History, etc., Second Surg. Vol., p. 336.

weapon was withdrawn.¹ Baron Larrey recorded three cases in which aneurismal varix of the axilla occurred in consequence of incised wounds involving the axillary artery and vein. M. Bérard reports a case observed by Dupuytren, in which it was caused by a gunshot wound of the axilla. Dr. J. C. Nott, in 1841, reported a case of successful ligation of the subclavian artery for arterio-venous aneurism. Dr. J. P. C. Wederstrandt also reports an aneurismal varix following a gunshot lesion of the subclavian vein and artery, which the patient survived seven years, finally dying of another disease. M. Legouest, too, relates a case that resulted from a musket-ball wound of the left axilla, at Balaclava.² Above I have presented an example of aneurismal varix of the left thigh, which was caused by an incised wound of the femoral vein and artery. Hennen records a case in which aneurismal varix of the right thigh was caused by a musket-ball wound of the same vessels.³ Many examples of arterio-venous aneurism of the thigh have been reported. Furthermore, Dorsey has detailed a case in which aneurismal varix of the leg resulted from a gunshot wound.⁴

TREATMENT OF ARTERIO-VEIN ANEURISMS.—Arterio-venous aneurism in the neck, as far as the published cases enable us to judge, does not often prove fatal, if it be let alone. This lesion should not be interfered with, unless, from its growth, inconvenience arises or danger is threatened. In some comparatively rare instances this will happen. Then the treatment by compression should first of all be tried. Medini reports a very unpromising case of arterio-venous aneurism of the neck, which was completely cured by steady, long-continued pressure applied with Signorini's tourniquet.⁵ Should compression fail, ligation must be resorted to. On theoretical grounds, Anel's and Hunter's plans of ligation have often been employed, but, on the whole, with very disastrous results. I have already presented such an example of disastrous failure. Follin has collected ten instances of arterio-venous aneurism occurring in the lower extremity, of which five were treated by placing a ligature on the cardiac side of the lesion, as in Anel's or Hunter's operation, all of these ending fatally. He also has collected nine examples of arterio-venous aneurism occurring in the upper extremity that were treated in the same way; three terminated fatally; in five cases there were relapses; in one a cure was reported. The most frequent cause of death was gangrene.⁶ The late Prof. Spence published an example of arterio-venous aneurism of the thigh, which was successfully treated by ligaturing the femoral artery above and below the lesion.⁷ There are on record a considerable number of cases that were successfully treated on this plan.

When it becomes imperative to operate, the proceeding which promises the best result is to carefully dissect the skin from the tumor, having previously applied Esmarch's apparatus for the bloodless operation, and, on exposing the injured artery, to ligate it above and below the lesion with carbolized catgut. When feasible, a third ligature should be passed around the channel of communication between the vein and the artery, in order to avoid any possible failure arising from that source. The difficulties attending this operation must not be underestimated; and the surgeon, when about to under-

¹ American Journal of the Medical Sciences, 1867, January, pp. 44-46; April, pp. 339-340.

² Med. and Surg. History of the War of the Rebellion, First Surg. Vol., p. 612.

³ Military Surgery, pp. 158, 159.

⁴ Nouveau Dictionnaire de Méd. et de Chirurg. pratiques, t. xix. p. 586. Paris, 1874.

⁵ Bulletino delle Scienze Mediche, Jan. 1880; London Medical Record, April 15, 1880; Med. News and Abstract, June, 1880, pp. 363, 364.

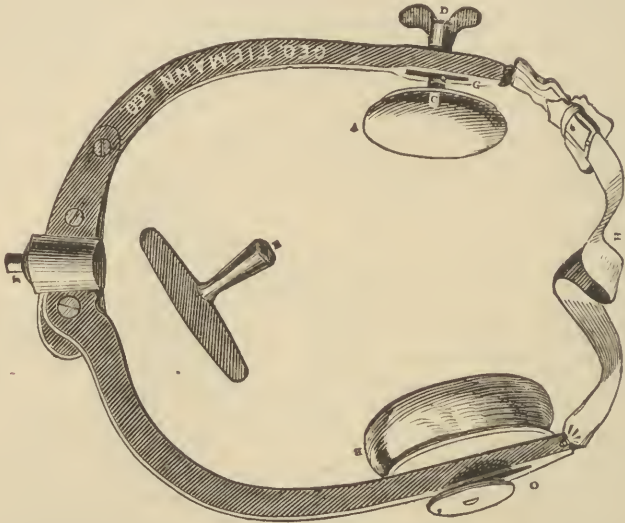
⁶ Med. and Surg. History, etc., Second Surg. Vol., p. 337. Foot-note 3.

⁷ Edinburgh Medical Journal, July, 1869; American Journal of the Medical Sciences, October, 1869, p. 562.

take its performance, should call to mind the regional anatomy of the part, and the structural changes which may possibly have taken place. The wound of operation must be treated antiseptically.

The accompanying wood-cuts illustrate two ingenious forms of instrument well suited for the compression treatment of any form of aneurism:—

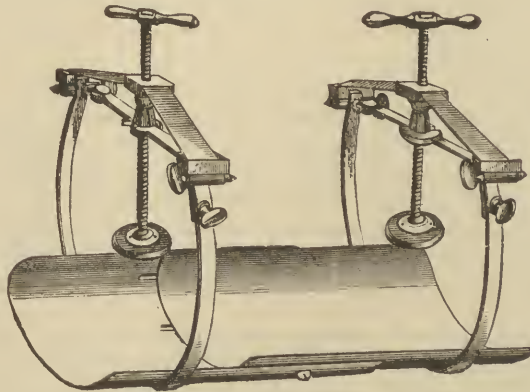
Fig. 452.



May's tourniquet for the treatment of aneurism. A. Pad of pressure. B. Pad of counter-pressure. C. Ball and socket-joint in the pad of pressure, which is governed by the screw and nut D. E. Key by which, when applied on F, the pads can be approximated or separated. G. Fenestra, by which the pads can be adjusted. H. Strap and buckle.

The action of Briddon's instrument (Fig. 453), is made *elastic* by running the screws through tense India-rubber bands; it can be tolerated for a long time without producing any annoying complication.

Fig. 453.



Briddon's artery-compressor for the treatment of aneurism.

Pressure can be made at *two* points, the distance between which may be varied according to circumstances, or the instrument may be taken apart, and then a single

compressor may be used as a tourniquet. A smaller instrument can be made for the upper extremity ; also a larger one for compressing the abdominal aorta.

The hard rubber compressors are attached to the screws by ball and socket-joints, and they are fitted into concavo-convex caps of wood, protected by several layers of buckskin, which are put on just before screwing down, and should be well powdered each time that they are applied.

GANGRENE FROM ARTERIAL AND VENOUS OCCLUSION.

When, from the injuries of bloodvessels, mortification ensues, it is because the supply of normal blood, that is, of blood which is fit to sustain calorification and the normal processes of cellular and molecular nutrition, is so much impaired by the injuries themselves, that molecular as well as cellular life is extinguished, and putrefaction inaugurated, throughout the affected area. Gangrene from this cause is frequently met with, and very often proves fatal. Many instances have been mentioned in the foregoing pages, and in nearly all of them death occurred. The subject is therefore very interesting and important to the surgeon.

SYMPTOMS.—Calorification being suspended, the temperature of the affected part sinks to that of the surrounding atmosphere, unless it is kept up by artificial heat. The nervous sensibility, muscular contractility, and muscular elasticity are likewise abolished ; and a great weight, with, sometimes, great pain also, is felt in the affected limb or area ; the beating of the arteries, too, is no longer perceived in the affected region, but still the part is not yet wholly dead. The natural heat, sensibility, motility, and arterial pulsations, have been known to return eight days after these and other signs of gangrene had been observed and accepted. Changes in color also take place. The integuments assume a tallowy-white, dirty-yellowish, marbled, or brownish appearance. Dark-red streaks may form over the course of the superficial bloodvessels. Large vesicles or blebs, filled with a pale or a dark serum, not unfrequently appear. The epidermis becomes detached ; the color blue-black, then greenish ; putrefaction ensues ; emphysema from decomposition may distend the subcutaneous connective tissue and crackle under the fingers when pressed on ; and the peculiarly fetid odors which characterize mortification are sent forth to taint the air, oftentimes in spite of the liberal use of deodorizers and disinfectants. Occasionally, the sphacelus does not extend above the middle of the limb, as has been observed after the operation for popliteal aneurism ; more frequently it extends up to the ligature or the wound which produces the vascular occlusion ; but very rarely to a higher point.

CAUSES.—The *proximate* cause of anæmic gangrene is insufficiency in the supply of nutrient blood. The *efficient* causes are the vascular lesions which produce this insufficiency.

The traumatic lesions of bloodvessels which eventuate in mortification affect, (1) the *main arteries* ; (2) the *main veins* ; and, (3) the *collateral channels*.

The office of the collateral channels is vicarious as well as supplemental to that of the main channels, and is of such extreme importance in the animal economy that, when their constitution is normal and their operation wholly unembarrassed, it is almost impossible for anæmic gangrene to result from traumatic causes. The injuries of the arterial and venous trunks which induce mortification are always complicated with traumatic lesions, or impaired action, or imperfect development of the collateral branches. This

point is mentioned, *in limine*, because of its great practical importance. When the great vessels of the extremities are occluded in accidents or in surgical operations, our sole hope of maintaining the vitality of the member often rests upon protecting the collateral branches from pressure and from obstruction in every form.

I. GANGRENE FROM ARTERIAL OCCLUSION.—The lesions of the main arteries which cause anæmic gangrene are (1) *complete division*, of which a considerable number of instances have been mentioned in this article; (2) *occlusion from the division and recurvation of their inner and middle coats*, of which a considerable number of cases were mentioned in the section on lacerated wounds and ruptures of arteries; (3) *occlusion by compression from blood extravasated* within the arterial sheath in consequence of contusion; (4) *occlusion from traumatic thrombosis*, the result of arterial contusion and inflammation; (5) *occlusion from traumatic embolism*, the migratory plugs consisting of blood-clots formed or detached in consequence of injuries; and (6) *occlusion from ligation*, or the application of ligatures. Several examples illustrating the last three forms of arterial lesion, in which gangrene ensued, have also been mentioned in the foregoing pages. When anæmic gangrene results exclusively from arterial obstruction, and no impediment whatever exists to the flow of venous blood, it is always a *dry gangrene*.

II. GANGRENE FROM VENOUS OBSTRUCTION.—If we apply to a limb circular compression sufficient to intercept the course of the venous blood, as sometimes has been done by bandaging fractured limbs too tightly, the limb swells, turns livid, and mortifies. The tissues perish because the effete or venous blood cannot pass out so as to give room for the fresh arterial blood to enter and nourish them. Thus, venous obstruction, in rare instances, causes mortification, by leaving no way of escape for the blood which has been carried into a limb by the arteries, and has there become exhausted of its nutrient properties, or effete. This, however, cannot well happen unless the compression be circular. The venous canals are, as a rule, more numerous, as well as more capacious, than the arteries, so that when one trunk happens to be obstructed, the others are usually found ready to perform its office. Not so, however, when several contiguous trunk-veins are occluded; or in cases, where all the vessels of a limb are strongly compressed by a profuse infiltration of serum, or by a copious extravasation of blood, or by a wide-spread effusion of the products of inflammation into the connective tissue of a limb, where the fasciæ or aponeuroses, both superficial and deep, being strong and unyielding, act like circular bands to strangulate the parts. Gangrene from venous obstruction is always *humid*.

The injuries which obliterate the venous canals are *severance*, *traumatic thrombosis*, *deligation*, and *compression*. Many examples of these have been presented in the foregoing pages. The occurrence of venous obstruction is denoted by the development of a cyanotic tumefaction of the limb, wherein the swollen subcutaneous veins can usually be discerned beneath the purple or venous-hued skin; also, by the development of a wide-spread œdematous infiltration, by which the affected limb sometimes becomes enormously distended, presenting the features characteristic of *phlegmasia alba dolens*.

III. GANGRENE FROM OBSTRUCTION OF THE COLLATERAL CIRCULATION.—Do the anastomosing branches of arteries (that is, their collateral channels) really perform the important part which I have claimed for them in the causation of anæmic gangrene? Here, as everywhere else in the domain of practical surgery, the lessons derived from clinical observation are all-important; and

the two annexed examples will serve to answer this question, and to illustrate the subject in a useful manner:—

A man was wounded in the axilla by a sword, and much blood was instantly lost; a large tumor rapidly filled the axilla, and the man fainted. On the fourth day, the forearm was cold, and the skin on it of a yellowish tint; hemorrhage recurred. The tumor increased, and was attended with obscure pulsation; the skin covering it was red and tense. In this state, on the seventh day, the man entered the Hôtel-Dieu. Desault laid the swelling open by an incision six inches long, commencing underneath the acromial third of the clavicle, and extending downward and outward. A great quantity of coagulum, followed by a stream of fresh blood, rushed forth, in spite of the compression which was applied to the subclavian artery above the clavicle. Desault seized the mouth of the artery (it was divided above the origin of the subscapularis) with his finger and thumb, and thus commanded the hemorrhage. The lower as well as the upper end was then ligatured. In the evening, after the operation, obscure pulsation was observed at the wrist, and the limb had in some degree regained its natural heat. The veins on the back of the hand and arm were filled with blood. No doubt existed that the circulation was re-established. On the third day after the operation, suppuration had commenced, and sloughs were observed in the wound. On the fourth evening an erysipelatous redness was noted on the forearm. On the next day the temperature of the limb fell, the nails became dark-colored, and purple spots appeared on the arm. On the sixth day after the operation the limb was vesicated and gangrenous, and the patient died.¹

In this case, mortification had occurred after the circulation had been re-established through the collateral channels; and must, therefore, have been due to obstruction of those channels, which might readily have resulted from compression caused by infiltration of the connective tissue surrounding them with inflammatory products, that is, from compression caused by inflammatory swelling, the inflammatory process having spread from the suppurating and sloughing armpit to the shoulder.

Hodgson mentions another example of the same sort:—

An officer received a stab-wound of the axillary artery by a sword. He soon fainted, and the hemorrhage ceased. The vessel was ligatured a short distance above the wound. The arm was then cold, and no pulsation could be felt in its arteries. On the third day, however, the arm was perfectly warm, and its veins were turgid with blood; but on the fourth day gangrene attacked the shoulder, and the patient died in the evening. *Autopsy*—The axillary artery was found completely divided below the origin of the circumflex. The ligature included also three of the brachial nerves. The axillary vein was wounded, but not included in the ligature.²

In this case, also, mortification occurred after the circulation had been perfectly re-established by means of the anastomosing branches or collateral channels at the shoulder. Inasmuch as the appearance of gangrene cannot be accounted for by the lesion of the brachial nerves, it must be ascribed to obstruction of the collateral circulation, which was probably caused by the extension of inflammatory swelling from the wounded armpit to the shoulder.

The collateral channels may be dangerously obstructed by pressure exerted upon them from careless bandaging, or by the position in which a limb may be placed, as well as by the compression which arises from œdematous, inflammatory, and hemorrhagic swelling. The aponeuroses or fasciæ cause strangulation only by acting as unyielding bands.

The simultaneous occlusion of the main artery and vein of a limb does not cause mortification, unless the collateral channels are also obstructed. In

¹ *Œuvres Chirurgicales de Desault, par Bichat, t. ii. p. 553.*

² *Op. cit., pp. 355, 356.*

some examples of this sort, wherein gangrene occurred, that have been related above, the collateral channels, both arterial and venous, were obstructed by pressure from œdematous and inflammatory swelling.

The cerebral softening which sometimes follows deligation of the common carotid artery is usually anæmic gangrene of the brain.

TREATMENT OF GANGRENE FROM VASCULAR OBSTRUCTION.—When wounds have been received, or when surgical operations have been performed, which are liable to cause anæmic gangrene, the treatment should be so conducted as to keep the collateral channels free from obstruction. When from any cause we ligature the principal vein as well as the principal artery of a limb, special care should be taken to cherish the collateral circulation, both at the time of and subsequent to the operation. The causal indications must always be met, as far as possible, by abating inflammatory and other swellings. Strangulating aponeuroses or fasciæ should be divided by appropriate incisions. The old plan of treating gunshot wounds by dilating them with the knife, lessened the liability to mortification.

In some situations, as, for instance, at the bend of the knee, obliteration of the main artery, when it is attended with much injury of the surrounding parts, is so sure to be followed by gangrene as to make primary amputation advisable.

In gangrene from the occlusion of bloodvessels, no line of separation, as a rule, is formed. There is, therefore, nothing to prevent the flow of putrid blood and other products of decomposition from the mortified part into the rest of the organism. Hence arise the great risk of septicæmia and the great fatality in these cases. Hence, too, amputation should be performed not very far below the site of the vascular lesion, as soon as gangrene appears.

Early amputation, likewise, affords the only means of preventing the gases which result from decomposition in the gangrenous part, from entering the veins and passing on to the right side of the heart, thus causing sudden death, as happened in several cases reported by M. Parise,¹ which I have already mentioned in speaking of air in veins.

Antiseptic precautions during, and antiseptic treatment after, the operation are of great importance.

HÆMOPHILIA, OR THE HEMORRHAGIC DIATHESIS.

This disease is attended with a remarkable propensity to bleed, on very slight or even without any apparent provocation. Hence those subject to it have been familiarly called *bleeders*.

DEFINITION.—Hæmophilia may be defined as a *congenital* and *habitual* disposition to the occurrence of hemorrhage. The extremely obstinate and dangerous hemorrhages for which bleeders are noted, usually begin in the very *earliest* years of life, and *habitually* recur. It is very uncommon for this peculiar hemorrhagic habit to originate in middle life so as to warrant us in regarding the disposition as acquired. It is equally uncommon for one who was a marked bleeder in infancy, and in whom the disposition was congenital, to completely lose the idiosyncrasy in early youth, and remain thereafter free from hemorrhagic attacks. In fact, the *congenital* origin and *habitual* nature of the disposition are so constantly observed together in the so-called bleeders, that although each of these attributes is doubtless important by itself, it is

¹ Archives Gén. de Méd., Novembre, 1880.

unquestionably their combination that constitutes the chief characteristic of hæmophilia. (Immermann.) It is just these two attributes which chiefly distinguish hæmophilia from other hemorrhagic affections, particularly scurvy and purpura hæmorrhagica. All of the other forms of hemorrhagic diathesis, especially the two just mentioned, present neither of these attributes, but are essentially acquired and transitory processes. Hæmophilia, on the contrary—at least as far as we can judge from the clinical phenomena—does not appear in any true sense a pathological process or morbid “accident,” but rather an abnormal “condition” of the living organism, and probably depends for its material substratum not upon any tissue-change which runs a definite course, but rather upon an original vice of structure.

HISTORY AND GEOGRAPHICAL DISTRIBUTION.—Our knowledge of hæmophilia as a specific disorder is, excepting the reports of a few ancient cases, entirely a modern acquisition. Toward the close of the last century, reports of families whose members were peculiarly subject to it began to be published in England (1784), in Germany (1793), and in America (New York, 1794). The word “bleeder” appears to have been first used in America. Nevertheless, it is to German writers that we are principally indebted for our knowledge of the subject.

This disorder, geographically, is not uniformly distributed, but is much more prevalent in some countries than in others. For, of 219 families, in which occurred 650 authentic cases, 94 lived in Germany, 52 in Great Britain, 23 in North America, 22 in France, 10 in Russia and Poland, 9 in Switzerland, 6 in Sweden, Norway, and Denmark, 2 in Holland and Belgium, and 1 in the island of Java; total, 219. (Immermann.) Thus, it appears that the Anglo-Germanic race is peculiarly susceptible to this disease. The Latin races, however, are not entirely exempt, for France is credited above with 22 bleeder families.

ETIOLOGY.—Family transmission is unquestionably the most striking and important of all the known causes of hæmophilia. Grandidier speaks of it as “the most hereditary of all hereditary diseases.” Immermann finds that the 650 authentic cases of bleeders have been distributed among 219 families, or very nearly three bleeders to a family. In fact, when one case occurs in a group of blood-relations, other members, sooner or later, are almost always affected. The disease, when having its starting-point in a single individual, or in several members of a family whose parents and ancestors were entirely free from it, is capable of *direct transmission* from one generation to another. For instance, the disease could be directly traced in two of the American bleeder families through the entire interval from 1720 to 1806; and of two unrelated bleeder families at Tenna, in Granbünden, one at least has been affected since 1770, and in the two families together the affection had gained such headway by the year 1854, that, at Tenna alone, out of a total population of 165, there were at that date no less than 15 bleeders. But the most important mode of propagation is by means of what may be called *indirect transmission*. Thus, after one or more cases have appeared among the children of healthy parents, the disorder is usually handed down, not as much by the bleeders themselves as by their non-bleeder brothers and sisters, and this singular mode of transmission of the outward manifestations of the disease may be repeated for several generations. A very large number of actual bleeders die from the disease so early in life as to be unable to take any share in the propagation of the anomaly. But the bleeder families present another remarkable peculiarity, to which attention was first called by Wachsmuth, namely, the *extraordinary fruitfulness* of the non-bleeder bro-

thers and sisters; for direct investigation has shown that the average number of legitimate births in bleeder circles is nearly twice the general average. (Immermann.) Hence, hæmophilia is a disorder of terrible importance to the welfare of the families concerned.

Hæmophilia, fully developed, occurs in *males* much more frequently than in females. Of 650 authentic cases, there were 602 in males and only 48 in females. In hardly any other disorder is the predisposing influence of sex so strikingly apparent. So, too, in bleeder families, it is much more common for the sons alone to be affected than for the sons and daughters, or the daughters alone. When the disease appears in both sexes in such families, the number of male bleeders usually exceeds that of the female bleeders; and, finally, the instances are much more numerous where all the sons without exception are bleeders, than where the disease attacks all the children, daughters as well as sons, or all the daughters alone. Such facts clearly show that the predisposing influence of sex, in this regard, is not merely a general law governing the gross statistics, but is likewise a radical differential principle, the operations of which are special in character, and discernible even in the smaller groups that are represented by the children of single families.

But, while females are far less subject to fully developed hæmophilia than males, the actual share of the female sex in cases which, although not fully developed, really belong to the pathological domain of hæmophilia, is in all probability much larger than appears from the statistics just given, or perhaps than can possibly be shown by any statistics. It is not unlikely, as Grandidier has pointed out, that imperfectly developed and anomalous outbreaks of the bleeder disposition, which are manifested only transitorily and at certain times, *e. g.*, at the first appearance of the menses, and in childbirth, etc., are really more frequent in females than is commonly supposed, the true relation of these attacks to hæmophilia being overlooked. In girls, the diathesis often remains latent to a certain extent, and frequently is first brought into activity by fixed causes apparently connected with the period of reproductive activity. How often may not, indeed, hemorrhage in a hæmophilic puerperal woman have been quoted as the result of defective involution of the uterus, or fatal flooding as the result of atony of the womb? Moreover, the female sex is in reality to be regarded as the more intensely affected, because it possesses in a far higher degree than the male the capacity for transmitting the disease by inheritance to its offspring. For, as Grandidier also has pointed out, the males in bleeder families who themselves are bleeders, do not, as a rule, beget bleeder children by women who belong to non-bleeder families; in fact, the children in such cases are usually healthy and non-bleeders; but the children of women who themselves are bleeders are quite uniformly affected with hæmophilia. Again, the males in bleeder families who themselves are not bleeders, almost never beget bleeder children by women from other families; but among the children of women who belong to bleeder families, and are not themselves bleeders, some are almost always found who suffer from pronounced hæmophilia. In the transmission of this disorder, therefore, the maternal influence is far more important than the paternal; and, since the females are but rarely fully developed bleeders, while the male bleeders either die prematurely, or, as a rule, fail to reproduce the disease in their children, it follows that the non-bleeder women in bleeder families are, in fact, the most frequent and most efficient "conductors" of hæmophilia, and to them the hitherto constantly increasing spread of this affection is mainly due.

The first bleedings of hæmophilia take place in *very early childhood*, in a very large majority of instances. A considerable number of deaths have been reported in Jewish families from the rite of circumcision on the eighth day, as well as similar results in other families from cutting the frenum lin-

guæ soon after birth, or from accidental wounds. But the most common time for the full outbreak of the disease is at the end of the nursing period, or at the beginning of the first dentition, not only because the traumatic bleedings now become more frequent in consequence of slight contusions, excoriations, etc., but especially because the apparently spontaneous hemorrhages begin to appear about this time. There are also certain ages when the disposition to bleedings is particularly marked; and Grandidier calls attention to the fact that the second dentition, puberty, and in females the first appearance and the cessation of the menses, are specially critical periods for these patients. The general correctness of this view is proved by the experience of most of the reported cases. Finally, it is to be noted that with the advance of age there is very generally a gradual decline in the average intensity of the affection, and that accordingly the manifestations of the congenital anomaly are usually found to be most marked in youth, and to become much feebler toward middle life. In exceptional instances, however, the symptoms of hæmophilia recur again and again with undiminished intensity up to old age, and even then death may result directly from one of the hemorrhages.

No definite form of *physiological constitution* exhibits a specially marked predisposition to hæmophilia. There is, however, one peculiarity, namely, a certain delicacy and transparency of the skin, together with a superficial position and marked fulness of the subcutaneous bloodvessels, particularly the veins, which is mentioned by many trustworthy observers as so commonly noticeable in bleeders, that we can scarcely deny it a certain causal relation to hæmophilia.

The *Anglo-Germanic race* in both the old and the new world, exhibits a special disposition to the affection, as already mentioned. A similar predisposition, it may be added, appears to exist in the *Jewish race* also, for the disease has repeatedly been noticed among this people in connection with the rite of circumcision, and a considerable number of Israelitish bleeder families have likewise been reported.

The *primordial* causes of hæmophilia and the nature of the influences which originally operate in its genesis are entirely unknown.

But the *exciting* causes of the bleedings, that is, the influences which are able to produce an outbreak when the disposition, however acquired, already exists, are briefly as follows: Cuts, punctures, lacerations, contusions, wrenches, and strains, may all excite *interstitial* as well as *external* extravasations; but it is especially characteristic of bleeders that extremely obstinate and copious external hemorrhages, as well as very extensive interstitial hemorrhages, occur in them, not only after severe wounds and injuries, but also quite commonly after even the most insignificant traumatic accidents. Indeed, it seems as if it were just these very trifling injuries, so harmless in healthy persons as scarcely to attract attention, that are specially dangerous in bleeders; in fact, the mortality statistics of hæmophilia show that hemorrhages result far oftener from very slight than from severe wounds. Thus, simple punctures, the opening of small superficial abscesses, the application of leeches and cups, the extraction of teeth, cutting the frænum linguæ in young children, circumcision, and numerous other trifling operative procedures, have been followed by uncontrollable and ultimately fatal hemorrhages in so large a number of cases that any operation upon these patients, however slight, attended with bleeding, must be considered dangerous. The same is also true of slight accidental wounds of all sorts, such as pin-pricks, cutaneous abrasions, trifling contusions, etc.; for they likewise are very apt to be followed by most obstinate and alarming external hemorrhages, or by very diffuse ecchymoses. But some of these minor wounds are, as a rule,

attended with much more risk than others. For instance, circumcision, the extraction of teeth, and accidental wounds of the head and face are spoken of as exceptionally dangerous in bleeders, while venesection and vaccination are regarded as less hazardous. Still, all clinical observation shows that any traumatic lesion in a bleeder, whatever be its cause or situation, may excite a characteristic hemorrhage externally or interstitially.

Again, the danger from the same kind of wound in a bleeder, for instance, a leech-bite or a pin-prick, is not equally great at all times (Wachsmuth, Martin, Grandidier); thus, it appears that the individual disposition to hæmophilic hemorrhages varies considerably at different times. The critical periods of life for bleeders have already been mentioned. But it must be added that variations in the individual disposition of bleeders to the occurrence of traumatic hemorrhages, result from other causes which have not yet been fully determined. The change of season in spring and autumn, and the sultriness of air preceding a thunderstorm, have been mentioned with some plausibility; the evidence, however, is too imperfect to be conclusive.

Moreover, the occurrence of a traumatic hemorrhage in bleeders, at times, not only awakens a hitherto latent hæmophilia, but also materially aggravates, at least temporarily, the manifestations of an already developed hemorrhagic diathesis. To this almost all writers testify. Virchow, Grandidier, and others, have noticed that after the occurrence of a traumatic hemorrhage the patient is specially subject to the so-called *spontaneous hemorrhages*, those which are external as well as those which are interstitial. But the spontaneous bleedings of hæmophilia may occur independently of such a connection, and may even constitute the initial manifestation of the disease. Concerning them it is to be particularly noted that sometimes the hemorrhage occurs without any known exciting cause—entirely without prodromata, suddenly, as it were of its own accord.

But more frequently the *spontaneous hemorrhages* are preceded by precursory signs. The patient complains, before the hemorrhage, of flushings, of a hot sensation, and of more forcible pulsations in the heart and arteries. The face, especially the cheeks and the lobes of the ears, is markedly reddened, and feels hot; and there is also headache, together with mental excitement and sensitiveness of sight and hearing. The symptoms, however, as a rule, gradually decline, and entirely disappear when the bleeding is once established. These prodromata are obviously to be interpreted as the expression of an increased arterial tension, perhaps also of an abnormal fulness of the entire vascular system; hence the spontaneous hemorrhages thus characterized may properly be distinguished as *fluxionary* (Virchow), or even as *plethoric hemorrhages*. Grandidier also has observed that many of these hemorrhages are induced by influences which excite a more forcible action of the heart, such as alcoholic stimulants, mental emotion, and physical exercise, or which suddenly increase the volume of the blood, as for instance, copious drinking.

To summarize the *exciting causes* of the hemorrhages in bleeders: Most frequently they have a *directly* traumatic origin, but they also occur spontaneously, that is, without any kind of wound or mechanical injury. Still, many of even the latter hemorrhages are *indirectly* traceable to the influence of recent wounds, whereby the tendency to spontaneous hemorrhage is considerably increased, or, perhaps, is, for the first time, awakened. But when there has been no antecedent traumatic hemorrhage, the spontaneous bleedings generally manifest a distinctly *fluxionary* character, and are preceded by various symptoms of congestion and plethora. Finally, in rare instances spontaneous hemorrhages occur independently of any obvious cause, with every appearance of actual spontaneity, and must therefore be considered to result from unknown influences. (Immermann.)

SYMPTOMS.—The phenomena of hæmophilia are essentially of a *hemorrhagic* character.

The external hemorrhages that are *traumatic* always occur at the place of injury, which is most frequently situated in the skin and superficial parts. They are usually due to trifling accidents.

The external hemorrhages that are *spontaneous*, or non-traumatic, occur in a majority of instances from the mucous membrane of the nose and mouth, more especially the former, for epistaxis is by far the most frequent form. In 308 carefully described cases, hemorrhage occurred from the nose 152 times, from the gums 38 times, from the intestines 35 times, from the lungs 17 times, with the urine 16 times, from the stomach 14 times, from the female genitalia 10 times, from the tongue 6 times, from the external meatus auditorius 5 times, from the tips of the fingers 4 times, from the scalp 4 times, from the carunculae lachrymales 3 times, from ulcers of the skin 2 times, from the upper eyelids 1 time, and from the umbilicus long after the healing 1 time. (Immermann.) In very rare instances, among bleeders, hemorrhage occurs into the abdominal and other serous cavities.

The external bleedings, whether traumatic or spontaneous, are almost always capillary, that is, parenchymatous in character. All the descriptions agree that the hemorrhage takes place, as a rule, not from large vessels, but from numerous vessels of the smallest size (capillaries), and from a great number of minute openings, as if from the pores of a compact sponge saturated with a liquid. Nevertheless, the blood is poured out under a comparatively very strong pressure. The danger, however, results not so much from the profuseness of the hemorrhage as from its *persistence*; in fact, it is this obstinate persistence of every hemorrhage, whatever its origin, which is the most important as well as the pathognomonic peculiarity of the bleeder diathesis. Not unfrequently, an originally trifling hemorrhage which there was every reason to expect would soon cease spontaneously, or yield to treatment, persists in bleeders, in spite of all efforts to restrain it, for hours and days and weeks, until extreme anæmia or death is produced. But the tolerance with which bleeders bear the great losses of blood, and the rapidity with which restoration of the lost blood is usually effected, are still more remarkable.

Interstitial hemorrhages, particularly those of an undoubtedly traumatic origin, often constitute the earliest visible manifestations of hæmophilia; they frequently occur during the first few days of life, or even during birth, from pressure or other mechanical injury of the body of the child during parturition. In after-life, interstitial bleedings occur not only as the direct results of injuries, but are also quite often observed in connection with the external hemorrhages, whether spontaneous or traumatic. In such cases, the surface of the body very frequently becomes covered more or less universally with numerous hemorrhagic efflorescences, which indicate the occurrence of multiple interstitial hemorrhages. The usual anatomical seats of the interstitial bleedings of hæmophilia are the skin and subcutaneous connective tissue. The regions most often involved are the back, the fundament, the neighborhood of the trochanters, and the back of the neck; in brief, those parts of the body which are most subjected to pressure from posture. The *spontaneous* interstitial extravasations, however, are most frequently observed in the hairy scalp, the genitalia, particularly the scrotum, and the extremities; more rarely on the trunk and face. The subtegumentary extravasations sometimes are very copious, and constitute veritable hæmatomata. These blood-tumors have been noticed most frequently in the region of the false ribs, on the back; and especially on the inner surface of the thigh, the popliteal region, etc., in the lower extremities. These blood-tumors have varied considerably in size in the

reported cases; many of them were as large as a goose-egg or an apple, while several instances are mentioned of enormous tumefactions, as large as a child's head or larger, which had been produced by trifling contusions, or had apparently arisen spontaneously.

The so-called *rheumatic affections* are also of such frequent occurrence in bleeders, and their immediate relations, as to deserve special mention. The most important of these rheumatic diseases in bleeders are unquestionably the *joint-affections*. They comprise all the grades of arthritic rheumatism, from simple inflammatory arthralgia up to the most copious synovial effusion. But *rheumatic muscular affections* completely resembling, in their clinical features, the ordinary forms of rheumatic myalgia, are met with in bleeders still more frequently than the joint-affections, and very often are superadded to the latter. Besides, those subject to hæmophilia are peculiarly liable to *neuralgic attacks*, which most frequently involve the *dental branches of the trigeminus*. Grandidier mentions the striking frequency with which bleeders suffer from periodic attacks of violent tooth-ache, often independently of any obvious cause such as caries.

MORBID ANATOMY AND PATHOLOGY.—With regard to *anatomical changes*, no apparatus of the body seems to be abnormally affected in bleeders so uniformly as the vascular system (Virchow). Both the older and more recent writers speak of the striking superficiality and abnormal distribution of the cutaneous and subcutaneous veins and arteries, and especially of the abnormal structure and width of the arteries. Thus, in quite a large series of cases, the intima of the smaller and larger arteries (the temporal and radial, the aorta, pulmonary, carotid, etc.), was found to be remarkably thin, and sometimes actually transparent, without any apparent diminution, however, in the elastic retractility of the coats of the vessels (Virchow); while in a certain number of these cases the lumen of the large arteries (aorta, pulmonary, etc.), and of their main branches, was abnormally narrow throughout the entire extent of the vessels (Schliemann, Virchow, Uhde). Very generally, also, where the autopsy was carefully made, the intima of both the large and the small arteries was distinctly seen to have undergone a partial fatty degeneration, quite analogous, as regards its locality and other characters, to the degenerative changes of the inner coat of the vessels in anæmia and chlorosis (Immermann).

There is, however, a second factor which may possibly be of the highest importance in producing the bleedings of hæmophilia—a factor, moreover, which is not dependent upon the configuration of the vessels, but is directly connected with the absolute quantity of the habitual supply of blood. The greater this habitual supply, and the more the vascular apparatus is permanently overfilled in consequence of it, the more readily the clinical phenomena peculiar to the bleeder disease may arise, and the greater will be the tendency not merely to hemorrhages in general, but particularly to those of a profuse and scarcely controllable character. Thus, it may readily be conceived that, in certain instances, the habitual existence of a high degree of absolute plethora may of itself be sufficient to maintain a bleeder disposition, without the intervention of the vascular anomalies above described. Or, in other words, we may suppose that although, in moderate degrees of habitual plethora, hæmophilia requires for its development the concurrence of certain favoring conditions on the part of the vessels—*e.g.*, delicacy of their walls and narrowness of their channels—still, the affection may now and then manifest itself as a clinical form of disease entirely unconnected with the vascular lesions above described (Immermann). The introduction of this second factor, that is, variations in the volume of blood, enables us to account satisfactorily for the fact that the dis-

position of bleeders to hemorrhages, and the severity of the hemorrhages themselves, are usually by no means the same at all times of life, but present all sorts of fluctuations and differences. To this second factor must be added the *habitually forcible contractions of the heart*, of which we have ample evidence in the unusually hard pulse and apex-beat of many hæmophilic individuals, and particularly in the *cardiac hypertrophy* occasionally found at their autopsies.

To epitomize our present knowledge of its *pathology*, we may state that hæmophilia is, in general, a congenital and habitual form of the hemorrhagic diathesis, in which the oft-recurring and easily-induced hemorrhages for the most part owe their extraordinary vehemence, obstinacy, and danger, to an equally congenital and habitual disproportion between the volume of the blood and the capacity of the vascular apparatus, resulting in an abnormal increase of lateral pressure within the vessels. Moreover, in many instances, functional erethism of the heart, as well as cardiac hypertrophy, by inducing a tendency to congestions, affords important aid in producing the hemorrhages themselves, and in imparting to them their abnormal clinical character. Finally, neurotic influences occasionally act as an additional factor by temporarily increasing the habitually congestive diathesis.

PROGNOSIS.—The *ultimate result* of hæmophilia in a great majority of cases is *death*, possibly in the first attack, but usually from one of the hemorrhages in later life. The mortality of the disease is therefore very high, and at the same time very premature, on account of the generally very early outbreak of the diathesis, and its intensity during the first period of life. A very large number of bleeders succumb to the murderous affection in early youth, the rate of mortality between the first and seventh years being particularly excessive, while only a comparatively small proportion of bleeders, suffering from the well-marked and fully developed form of the disease, escapes the constantly-threatening danger of a fatal hemorrhage until the age is reached when the diathesis is frequently observed to abate spontaneously, or to become latent (Immermann). There can be no question, therefore, as to the extremely pernicious character of hæmophilia, especially in childhood and youth. This view is confirmed by the results noted in 212 fatal cases of hæmophilia that were collected by Grandidier. Of the entire number of patients, 121, or more than one-half, died from hemorrhage before reaching the eighth year, and only 24 survived the twenty-second year.

TREATMENT.—Every precaution should be taken to avoid all kinds of *injury*, and likewise all influences which determine the occurrence of *plethora* and *congestions*. If a tendency to constipation be present, it should be combated with saline cathartics, especially Glauber's salt; and not unfrequently the manifestations of plethora can be palliated by the vigorous use of that remedy when constipation is not present.

The *traumatic external hemorrhages* of hæmophilia always demand immediate interference. Internal medication should always be employed in such cases, as well as local measures. Among the latter, *compression* continued for a considerable time, perhaps for days, is the most reliable. The *actual cautery* rarely suffices, and therefore should not be employed in these cases. The *twisted suture* has in many instances been found of great service, when the wounds were very small, such as leech-bites, or consisted of simple linear incisions, and has but rarely been followed by secondary hemorrhage. To arrest bleeding from the dental alveoli after the extraction of teeth, which is often very difficult, the most effectual plan of treatment consists in applying a tampon saturated with perchloride of iron, and retaining it in place by a piece

of cork, or by a metallic plate fastened to an adjacent tooth, so as to effect permanent pressure for weeks, if necessary—an operation which can be readily performed by any dentist.

Of internal remedies, the most trustworthy are *acetate of lead* and *ergot*, in large doses frequently repeated. The mineral acids, alum, tannin, etc., are less reliable. In every case, therefore, where the hemorrhage is at all serious, either plumbic acetate in doses of two grains every two hours, or fluid extract of ergot in doses of thirty minims every two hours, should be given until either the bleeding is arrested, or symptoms of poisoning ensue. In bad cases both remedies should be simultaneously administered. At the same time restlessness should be quieted by exhibiting opium or morphia. It has not unfrequently happened that this method has succeeded in rapidly arresting the hemorrhage after local measures have proved entirely fruitless. In cases of internal bleeding, we are, of course, compelled to rely on this method exclusively.

The *spontaneous external hemorrhages*, that is, those of non-traumatic origin, when preceded by various symptoms of plethora and congestion, should not be interfered with until the engorgement of the vessels has passed away; for in checking the hemorrhage prematurely, we might do far more harm than good. Otherwise, the plan of treatment is the same as the above.

The *interstitial cutaneous hemorrhages* (petechiæ, ecchymoses, vibices) require no special treatment in bleeders, inasmuch as the loss of blood is inconsiderable; but as to the *subcutaneous interstitial hemorrhages*, that is, the *hamatomata*, it is of the first importance to protect these tumors from mechanical injury, and to abstain from opening them prematurely by incision or puncture.

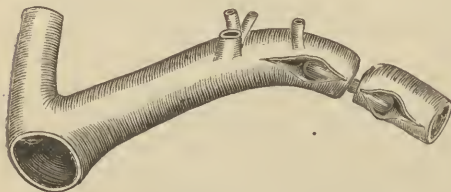
The *rheumatic* complications of hæmophilia are to be treated in the same way as under ordinary circumstances, with the important exception that all remedies should be carefully avoided which may possibly excite hemorrhage. (Immermann.)

Grandidier and others assert that the administration of mercury in any form in the treatment of these rheumatic affections is commonly attended by a temporary aggravation of the hemorrhagic diathesis, and it should therefore be strictly avoided.

The following example of hæmophilia was reported during the late civil war. It will serve to show how much the operation of deligating the main artery is worth in preventing hæmophilic bleedings from gunshot wounds:—

Sergeant Henry B., Co. D, 12th New Hampshire Volunteers, aged 21, was admitted to Emory Hospital, Washington, June 11, 1864, with a gunshot wound of the right

Fig. 454.



Showing the right subclavian artery divided by a ligature in its third part. The preparation was taken from a bleeder. It has been opened longitudinally, behind, to display the small fibrinous coagula. Spec. 2812, Sect. I., A. M. M. (Posterior view.)

shoulder, received at Cold Harbor on the 3d. A minié-ball had entered below the clavicle and passed out at the anterior aspect of the arm, about three inches below the shoulder-joint. There was also a flesh-wound of the upper third of the right thigh. The patient had a hemorrhagic diathesis, which his father stated was hereditary in the family—for example, a simple cut of the finger would cause hemorrhage to such an amount as to endanger life. Under these circumstances, and upon consultation, it was decided after his first attack of hemorrhage to ligate the subclavian. The operation was successfully performed on June 17, by Surgeon N. R. Mosely, U. S. V. Strong hopes were entertained of the patient's recovery; but, unfortunately, in addition to his peculiar diathesis,

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he had a severe cough, which it seemed almost impossible to relieve or arrest temporarily. On the morning of the 29th, while in conversation, the artery gave way, and death from hemorrhage was almost instantaneous. The accompanying wood-cut (Fig. 454) represents the specimen which was obtained at the autopsy. It consists of the right subclavian, of the inferior part of the right carotid, and of the distal end of the innominate. The commencement of the vertebral and of the superior intercostal are also shown, together with the thyroid axis and transversalis colli. There were slight fibrous exudations on either side of the point at which the ligature cut through.¹

This patient survived the operation for twelve days. During this period there was no hemorrhage from the original wound. Nevertheless, he died almost instantaneously from a hemorrhage that resulted from the sudden giving way of the ligatured artery. The wood-cut shows that the occluding coagula were very small.

But, upon the whole, the manifestations peculiar to the bleeder diathesis were not very striking in this case. It is, however, not improbable that the privations and hardships attending a soldier's life in the field, by lessening plethora and the tendency to plethoric congestions, had considerably modified the diathesis in his person.

INTERMEDIARY HEMORRHAGE.

The term intermediary hemorrhage embraces all the effusions of blood from wounds or from wounded bloodvessels which occur in the *intermediary period*, that is, subsequent to the arrest of the primary bleeding or close of the primary period, on the one hand, and prior to the establishment of suppuration on the fifth or sixth day which marks the beginning of the true secondary period, on the other hand. In this interval of time, the phenomena of reaction, whether it be simply normal or more or less strongly inflammatory, present themselves, and thus the intermediary period itself becomes distinctly marked or characterized, and distinguished both from that which precedes and from that which follows it. The hemorrhages which occur in this period are, for the most part, products of the more or less violent reaction and excitement of the vascular system that properly belong to this period; wherefore, the division of traumatic hemorrhages into the *primary*, the *intermediary*, and the *secondary*, is not an artificial classification, but is founded on natural distinctions or differences of an important character. Even those writers who classify the hemorrhages which occur during the reactionary period with secondary hemorrhages, recognize an essential difference between them, which has been well expressed by the late Dr. George McClellan, who says, while speaking of the bleeding which often presents itself in wounds in the course of three or four days after their infliction: "This is called by all writers a secondary hemorrhage, but as there is still an ulterior form of bleeding in some classes of wounds, it is best to qualify this by the epithet *first form of secondary hemorrhage*, or *secondary hemorrhage from reaction*."² But, inasmuch as the pathogenesis of these bleedings is totally different from the pathogenesis of the bleedings which occur after suppuration is established, and which are known *par excellence* as secondary hemorrhages, it is beyond a doubt far preferable to designate them as intermediary hemorrhages. Moreover, the term itself will serve to show in most instances, with precision, not only the period when the bleeding took place, but likewise the nature of the forces concerned in its production.

¹ Medical and Surgical History of the War of the Rebellion, First Surgical Volume, p. 540.

² Op. cit., p. 187.

Intermediary hemorrhages in general are obviously connected with increased vascular action, and result from the increased force with which the blood is driven through the arteries, during the period of reaction and inflammatory irritation that follows the "shock" of severe wounds, and the depression of profuse primary hemorrhage. During at least three or four days after the infliction of such wounds, it is always possible for a return of the hemorrhage to be effected by the violent reaction or excitement of the vascular system driving out the occluding coagula and forcing open the contracted orifices of the wounded arteries. The following example affords a good illustration of the intermediary as well as of the primary and secondary forms of traumatic hemorrhage:—

A temperate and healthy young man, aged 21, accidentally received in his right armpit the charge of one of the barrels of a bird-gun, loaded with pheasant shot, which produced "an enormous burnt wound in the centre of the axilla, with blackened and burnt edges, passing up along the course of the vessels toward the coracoid process. The powder, wadding, and shot had all been driven into the wound, and the physicians hoped, therefore, that the contusion of the surfaces, in addition to the coagulation, would enable them to prevent a return of the hemorrhage by the pressure of compresses and bandages." It should be stated that the infliction of the wound had been immediately followed by "an enormous hemorrhage," that he had fallen "into complete syncope at the door-step of his father's house," and that "the discharge had entirely ceased under fainting."

"About thirty hours afterward, however, a severe hemorrhage returned from the wound in consequence of vascular reaction forcing off the coagula from the torn vessels. He fainted again almost unto death, and remained several hours exceedingly prostrate, during which period [McClellan] was first called in consultation. As large tents well graduated in the form of compresses had been forced into the wound with styptics, to the total suppression of the hemorrhage," McClellan did not interfere.

"The case progressed very well after that for ten entire days, when, on turning over in his bed at night, a tremendous hemorrhage broke out again. He fainted, and they were able to suppress the bleeding until [McClellan] arrived and secured the subclavian artery just above the upper verge of the inflammatory swelling and engorgement. The sloughs of dead cellular tissue, and shot, and wadding, afterward came away through the original wound in the axilla, along with the suppuration, and the patient got well with a good use of his arm."¹

In this case the *primary hemorrhage* ceased on the occurrence of syncope; and the wound appears to have been dressed with compresses, retained in place by applying a roller bandage. Nevertheless, the blood coagulating in the wound did not succeed in effectually plugging up the open mouths of the injured arteries; wherefore it happened thirty hours afterward, when reaction supervened, that the increased blood-pressure, or the increased force of the circulation, drove out the plugs of coagula and started the bleeding afresh, thereby causing an *intermediary hemorrhage* of a most profuse character, which, however, again ceased on the occurrence of syncope, and was afterward held in check by strong compression.

Finally, when suppuration was fully established in the wound, and the sloughing tissues had begun to separate, *secondary hemorrhage* ensued, which, however, was suppressed by deligation of the subclavian artery, with probably a continuance of the local pressure; and the young man had the good fortune to recover with a useful arm.

But intermediary hemorrhage sometimes takes place from the great arteries of the trunk, as happened in the following instance, which occurred during the late civil war:—

¹ McClellan, op. cit., p. 191, foot-note.

A soldier, aged 23, received, near Petersburg, Va., on June 18, 1864, a gunshot wound of the right nates, the ball entering the pelvis at the sacro-iliac symphysis, and on the following day he was admitted into the Hampton Hospital at Fortress Monroe. On the 20th hemorrhage from the common iliac artery occurred, three quarts of blood being lost, and on the 21st death ensued. *Autopsy*—The ball was found lodged at the superior sacro-iliac symphysis, and the common iliac artery wounded.¹

The following case came under my own observation:—

A soldier, aged 37, received, at Spottsylvania C. H., Va., May 18, 1864, a gunshot fracture of the left humerus, for which the arm was amputated at the upper third by the double-flap method. On the 21st he was admitted to Stanton Hospital. On the 22d, profuse intermediary hemorrhage, arterial in character, suddenly occurred from the stump. The stump was immediately opened, and the bleeding was found to proceed from the brachial artery, the ligature having slipped off from it. The artery was again tied on the face of the stump, and the bleeding was permanently arrested. Most unfortunately, however, the patient was attacked with pyæmic pneumonia, and died on June 4.

In this case, intermediary hemorrhage occurred in the stump of an amputated arm, because the ligature slipped off from the end of the brachial artery; it appears that the ligature had been carelessly applied too near the end of the vessel, and that it had not been drawn with sufficient tightness before knotting. In consequence of this inexcusable negligence, the ligature was gradually pushed off from the end of the artery by its pulsations after reaction had taken place.

When secondary amputations of the extremities are performed through inflamed tissues, intermediary hemorrhages of a *parenchymatous* character not unfrequently ensue, as happened in the following example:—

Lieutenant-Colonel Maxwell, aged 22, was wounded at Five Forks, April 1, 1865, by a conoidal ball, which opened the left knee-joint. An attempt was made to save the limb, but suppurative inflammation ensued, and the thigh became infiltrated with purulent matter between the muscles, as high as the apex of Scarpa's triangle. On April 17, amputation at the middle of the femur, by the circular method, under ether, had to be performed, and the stump was dressed with cold water. On the 18th it was observed that hemorrhage continued, although twelve ligatures had been applied, and that altogether about eight ounces of blood had been lost. The stump was then opened, and liquor ferri persulph. fortis was applied with a camel's-hair brush to the whole surface of the wound, which was also left open and exposed to the air for about fifteen minutes; this proceeding entirely checked the sanguinolent oozing. The patient ultimately made a good recovery.²

Notwithstanding that all the arteries of appreciable size had been tied in this case, when reaction came on, bleeding took place from the capillaries of the stump, because they had lost the ability to spontaneously contract, and thus close their open mouths. Moreover, this paralysis of the muscular coats of these vessels appears to have been caused by the inflammatory process, which spread from the wounded knee-joint upward into the thigh.

But whenever the arteries are not completely nor transversely divided, but are only cut into or punctured, intermediary hemorrhages are very common. Sometimes a temporary arrest of the bleeding can be repeatedly effected in such cases by coagulation, contraction, and syncope, or by the application of pressure, and still, at every recovery or return of vascular power and excitement, the bleeding will be reproduced. The next two examples are in point:—

¹ Med. and Surg. History of the War, Second Surg. Vol., p. 333.

² U. S. Sanitary Commission, Surgical Memoirs, p. 176. New York, 1870.

Dr. Robert Battey ligatured the common carotid artery, in a man, for the relief of *repeated hemorrhages* following a deeply incised wound near the angle of the jaw, in the subparotid space. Tendency to syncope, following the loss of blood and the tying of the artery, was noticed for several days. Facial paralysis also appeared, but afterward subsided, and the man's health was subsequently entirely restored.¹

The hemorrhage appears to have recurred in this case whenever the reaction rose high enough to give the arterial pulsations a force sufficient to drive out the plugs of coagula which temporarily restrained the bleeding.

A soldier, aged 25, was wounded at Missionary Ridge November 25, 1863, by a ball which entered anterior to the left angle of the lower jaw, making a ragged opening nearly one inch long, and, fracturing that bone, passed downward and to the right under the tongue, cutting the floor of the mouth, and escaping from the right side of the neck behind and a little below the great cornu of the hyoid bone. On the evening of the 29th, intermediary hemorrhage from the mouth and the orifice of exit suddenly occurred, and between three and four pints of blood were lost before the hemorrhage was suppressed by tying the right common carotid artery, just above the omo-hyoid muscle. The hemorrhage was supposed to proceed from some wounded branches of the lingual artery. On December 2, the hemorrhage recurred both morning and evening; about midnight it again recurred with considerable force, necessitating the ligation of the left external carotid artery. After that the bleeding did not return, and the patient did well.²

In this case, too, the intermediary hemorrhage appears to have been caused by the bursting open of traumatic orifices in arteries which had been imperfectly plugged up with coagula, the reopening of these orifices being produced directly by an increased force in the arterial current of blood that was due to the reaction. Moreover, the hemorrhage recurred a number of times, and continued to recur until the circulation in both lingual arteries had been controlled by the application of ligatures.

TREATMENT.—I have repeatedly seen an intermediary hemorrhage produced by leaving a coagulum in the wound, which there acts like a warm sponge, and constantly promotes a tendency to hemorrhage during the reactionary period. In such cases, the coagula should always be thoroughly removed by the fingers, or by a suitable sponge: and the contact of fresh air will then often stop the bleeding. At all events, the surgeon can then find out the situation of the bleeding orifice, and can close it by a ligature or by a well-adjusted compress. Such wounds should always be cleansed with carbolized water, and should be dressed antiseptically. Drainage tubes, likewise, may often be advantageously inserted.

The occurrence of intermediary hemorrhage in the stump of an amputated limb generally makes it necessary to remove the dressings, to open the flaps, and to wipe off the coagula without delay. If the bleeding result from the careless or imperfect ligation of any artery, it should immediately be tied again, and in a secure manner. Likewise any artery that may have been overlooked should be securely tied. If the hemorrhage proves to be parenchymatous, and does not subside on wiping off the clots, the whole face of the stump should be washed with alcohol; in case this fails, the solution of the perchloride or persulphate of iron must be applied with a brush, or on lint, to the bleeding surface, a proceeding which was attended with admirable success in one of the cases related above. Intermediary hemorrhages in stumps always necessitate the employment of drainage tubes and antiseptic dressings.

¹ American Journal of the Medical Sciences, April, 1881, p. 505.

² Ibid., July, 1864, p. 276.

Intermediary hemorrhages from wounds where from any cause the bleeding vessel cannot be tied on each side of the aperture, and in the wound itself, not unfrequently require that the main artery should be ligatured as near the wound as practicable, on the cardiac side. This operation was attended with success in two cases related above.

Professor Hamilton says:—

“These intermediary hemorrhages are pretty frequent in military practice, and do not receive the attention they demand. If it were not that surgeons cannot always spare the time, when the number of wounded is very great, to make a very critical search for vessels which do not at first bleed, we would say that such bleedings implied culpable negligence on their part; but, however this may be, the omission to give it prompt and careful attention now, can only be excused on the ground of an extraordinary necessity. Some of these patients, left to themselves, bleed to death; but it more often happens that, in the hope of arresting the bleeding by pressure alone, or by cold applications perhaps, the surgeon entrusts the matter to an attendant, until the track of the wound and the adjacent structures become filled with coagula, which greatly increase the difficulties of subsequent ligation of the vessel; and which coagula, if the bleeding finally ceases, become depots for the formation of pus, thus greatly retarding the final cure. In the case of amputations made on the field, the same observations will apply. The intermediary hemorrhages lift the flaps, and prevent all possibility of immediate union. It is far better in such cases to re-open the wound, remove the clots, and tie the vessels; although it may be somewhat mortifying to the surgeon who made the original dressing, since it is apt to be construed into a reflection upon his skill.”¹

SECONDARY HEMORRHAGE.

By the term secondary hemorrhage we designate all bleedings from wounded vessels which occur subsequently to the establishment of suppuration, that is, subsequently to the fifth or sixth day after the infliction of the wound, and, likewise, all losses of blood occasioned by the spontaneous rupture or opening of the sac in cases of traumatic aneurism. This accident, in general, belongs to the secondary period in the history of wounds, strictly so called, and is closely connected with the processes of suppuration, ulceration, and sloughing, which pertain to that period, but especially with the unhealthy forms of suppuration. It may occur during any part of the secondary period; but, according to the statement of surgical writers, it is more liable to happen between the *seventh* and *twentieth* days, and especially about the *fourteenth* day. Before the seventh and after the twentieth days it is not often met with. I have, however, known several instances in which secondary hemorrhage occurred on the fifth and sixth days, on the one hand, and on the twenty-seventh, twenty-eighth, thirty-first, forty-first, forty-second, sixty-ninth, and eighty-fifth days, on the other.

CAUSES.—On investigating the clinical history of secondary hemorrhage, we find that it is produced by a considerable variety of proximate physical agencies:—

(1) This form of after-bleeding often results from contused wounds and contusions of the coats of arteries. A great many examples have already been mentioned in this article. In such cases, the bleeding is restrained until the bruised portion of the arterial tunics which becomes a slough is separated from the sound portion by a suppurative exulceration, and then the blood immediately begins to escape from the bruised vessel. The following ab-

¹ Military Surgery, pp. 213, 214. New York, 1865.

stract and the wood-cut accompanying it (Fig. 455) afford good illustrations of this topic:—

A soldier,¹ aged 25, was wounded June 3, 1864, by a conoidal ball which entered the left axilla, and lodged at the posterior border of the scapula; it was extracted, and simple dressings applied. On the 15th secondary hemorrhage to the amount of twenty ounces occurred. The wound was filled with lint, soaked in a solution of the persulphate of iron, and a compress applied. On the 16th hemorrhage again occurred, but yielded to strong pressure on the compress. On the 17th the patient was very pale and anæmic, and was suffering much pain in the arm and shoulder. The compress and plug were removed, and the blood gushed out alarmingly. The wound was at once freely dilated,

Fig. 455.



Gunshot contusion of left axillary artery; profuse secondary hemorrhage on the twelfth day; the vessel tied in vain. Spec. 2576, Sect. I., A. M. M.

and the axillary artery tied. The hemorrhage stopped, and at the same time the heart ceased to beat. *Necroscopy*—The axillary artery was found widely opened by sloughing, about the middle of its course, on the side next to the track of the ball. The specimen is represented in the accompanying wood-cut (Fig. 455), which exhibits a large, deep perforation, with jagged edges, involving nearly half the cylinder of the artery, about an inch above the origin of the subscapularis.

The missile which penetrated the axilla in this case was nearly spent, and lodged. In passing, it doubtless struck the side of the axillary artery (where the jagged aperture is shown in the wood-cut), and strongly bruised all its tunics, so that when the slough came away the canal of that vessel was widely opened.

(2) This variety of hemorrhage not unfrequently occurs in consequence of simple ulcerative inflammation, by which the coats of the arteries are perforated and their canals are opened. Displaced fragments of bone, through pressure, not unfrequently cause ulcerations in the walls of arteries, making apertures through which secondary hemorrhages take place. Several instances have already been mentioned. The following example came under my own observation:—

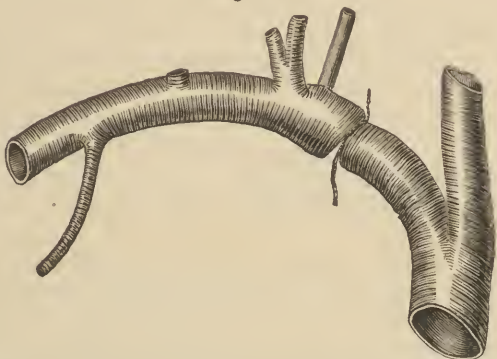
A soldier, aged 24, was wounded at Cold Harbor June 3, 1864, by a conoidal ball, which entered the right ankle in front of the external malleolus, and emerged below the inner malleolus, having fractured the lower end of the tibia and the astragalus. An effort was made to save the limb; on the 12th he was admitted to Stanton Hospital, where this effort was continued. He did tolerably well until August 27, when a profuse flow of arterial blood unexpectedly occurred from the wound, and reduced him very much. Without delay, and as a last resource, I amputated his leg, at the place of election, under ether. On dissecting the amputated limb it was found that the posterior tibial artery was the source of the bleeding; that the pressure of a piece of bone had caused ulceration and sloughing of its walls, and that the piece of bone itself had been displaced and driven against the artery by the missile. The articular surfaces of the tibia and astragalus were extensively comminuted.

A strongly supporting course of treatment was pursued, the patient receiving nutrients, stimulants, and tonics, as required, but these did not enable him to overcome the effects of the bleeding. He died from anæmic exhaustion twenty days after the hemorrhage.

¹ Med. and Surg. Hist. of the War of the Rebellion, First Surg. Vol., p. 554.

The following history and the wood-cut which accompanies it (Fig. 456) furnish good illustrations of the same topic. The operation of ligaturing the subclavian artery in the first part of its course was performed by Assistant-Surgeon S. C. Ayres, U. S. Volunteers:—

Fig. 456.



Ligature of the right subclavian artery within the scaleni muscles for hemorrhage from the subclavian, occasioned by a sharp fragment of bone, which had caused ulceration and perforation of the wall of the artery. Spec. 4729, Sect. I., A. M. M.

A scout¹ was shot on November 15, 1864, while on an expedition. The ball struck the external third of the clavicle, fracturing it, passed obliquely inward and backward, and emerged behind, near the spinal column, having opened the right pleural cavity. On December 14 a severe hemorrhage from the subclavian artery occurred, and this vessel was promptly tied, in the first part of its course, in the following manner: "A triangular flap was made by cutting parallel with the upper border of the clavicle and along the inner border of the sterno-mastoid—the two incisions meeting at the sterno-clavicular articulation. The sternal and part of the clavicular insertion of the sterno-mastoid, as well as the sternal attachments of the sterno-hyoid and sterno-thyroid muscles, were divided and turned backward with the fingers, and the cellular tissue carefully divided upon a grooved director. The par vagum was recognized and drawn inward, and the internal jugular vein outward. The artery was found lying quite deep below the clavicle; with some difficulty the aneurism needle was passed around the artery from below upward and the ligature drawn." The hemorrhage immediately ceased; but the patient sank rapidly, and died in half an hour. "*Autopsy*, twelve hours after death—Body much emaciated. The ball had fractured the outer third of the clavicle and the first rib. It had opened the pleural cavity in its course, and had fractured the spinous processes of the seventh and eighth vertebræ and made its exit on the left side of the spinal column. The hemorrhage from the subclavian was occasioned by a sharp spiculum of bone, which had caused ulceration of the coats of the artery. The right pleural cavity contained a large quantity of bloody serum, such as was discharged from the wound previous to death, and the lung was found completely hepatized. It is probable that a vein was ruptured by the ball, . . . and that the bloody fluid discharged from the pleural cavity before the arterial hemorrhage occurred was a mixture of venous blood and serum; but from the disorganized condition of the tissues it was impossible to tell which branch had been severed." If the hemorrhage had not occurred, the patient could not, in all probability, have lived many days. The accompanying wood-cut (Fig. 456) shows the terminal portion of the innominate, the lower part of the right carotid, and the right subclavian arteries, with a ligature, *in situ*, upon the subclavian, three-fourths of an inch from its origin.

The following case, likewise, is in point:—

Samuel Steinberger was wounded at Williamsburg, May 5, 1862, by a musket-ball, which entered the left side of his chin, fractured the lower jaw, carried away several

¹ Med. and Surg. History of the War of the Rebellion, First Surg. Vol., p. 546.

teeth, a part of the tongue, and the posterior wall of the pharynx, and lodged. He had extreme difficulty and distress in swallowing food or drink. On the 13th, the missile and several teeth were removed from an abscess above the clavicle. On the 16th, copious hemorrhage from the mouth occurred, and was suppressed by tying the common carotid artery, under ether. On the 23d, secondary hemorrhage again occurred, but this time, however, from the aperture through which the ball and teeth had been extracted, ten days before. An unsuccessful attempt was then made to find the bleeding point; and death occurred from hemorrhage, on the same day. An *autopsy* showed that the transverse process of the third cervical vertebra had been fractured by the missile, and that the vertebral artery had rubbed against a displaced fragment of it until the arterial tunics were worn or ulcerated completely through; hence the last hemorrhage.¹

The first of the two secondary bleedings which occurred in this case, appears to have proceeded from wounded branches of the external carotid, particularly the lingual artery, and was readily suppressed by tying the common carotid.

But simple ulcerative inflammation may spontaneously occur in the walls of arteries, and open their channels, as sometimes happens in depraved conditions of the organism; for example, those induced by typhoid diseases, by purulent infection, by scrofulosis, and by great losses of blood.

McClellan relates the case of a man who had, as a sequel of epidemic influenza, a critical abscess of one of the submaxillary glands, which, on being lanced, discharged an ichorous sanies. Next day, a violent hemorrhage broke forth, and continued until complete syncope. The bleeding recurred, and McClellan, who was called in consultation, dilated the orifice of the abscess, and, on sponging out the coagula, found that the facial artery had been opened by ulceration. The tissues were so much softened that ligatures cut through them. The actual cautery was then applied to the bleeding orifice, and the hemorrhage permanently ceased. The patient perfectly recovered.²

In the following example, the internal carotid artery was opened by spontaneous ulceration, and surgical hemorrhage took place:—

E. Schwartz³ relates the case of a man, aged 61, who had necrosis of the right angle of the lower jaw, with profuse and very fetid suppuration. One day profuse hemorrhage from the cavity of the abscess occurred; it was arrested by introducing a plug through the mouth. The next day it returned, and caused death. *Autopsy*—The internal carotid artery was found exposed, and infiltrated with ichorous pus; it presented anteriorly an oval aperture, one-fourth of an inch long, about an inch and a half from the bifurcation of the common carotid.

Sometimes the internal carotid artery, or a branch of the external carotid, is spontaneously opened by ulceration in cases of acute abscess of the tonsils, as happened in the following instructive instance:—

Ehrmann⁴ reports the case of a young Italian, who entered the hospital with *angina tonsillar's*. On the third day the abscess broke, and immediately half a litre of bright red blood poured from the mouth. Three hours later the hemorrhage recurred, but in less quantity. No pulsation could be felt in the tonsillar swelling. A third hemorrhage, more severe than both the preceding put together, caused the common carotid artery to be ligatured. The bleeding then permanently ceased. There was aphonia, which, however, disappeared in four days; no cerebral disturbance occurred. In six weeks the patient was discharged cured.

The rational treatment of such hemorrhages consists in tying the carotid; and inasmuch as the source of the bleeding in such cases, whether it proceed from the internal carotid or from branches of the external carotid, cannot be determined during life, deligation of the common carotid must be preferred.

¹ Medical and Surgical History of the War of the Rebellion. First Surgical Volume, p. 355.

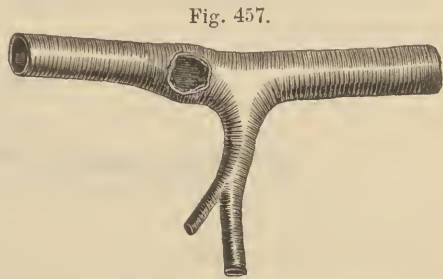
² Op. cit., p. 200; foot-note.

³ Gaz. des Hôpitaux, Mai 7, 1874.

⁴ Centralblatt für Chirurgie, No. 34, 1879.

(3) Secondary hemorrhages are often developed in consequence of the extension of a sloughing process, especially in unhealthy constitutions, from the adjacent tissues to the coats of the arteries themselves, when they are not primarily injured. The bleeding in such instances occurs on the separation or breaking down of the slough. The next two abstracts, together with the wood-cuts accompanying them (Figs. 457 and 458), most excellently illustrate this topic:—

A Confederate soldier, aged 27,¹ was struck by a musket-ball and captured, June 16, 1864. The missile entered three inches below the left clavicle and emerged at the posterior border of the left axilla. Nothing of importance occurred until July 10, when profuse arterial bleeding from the exit orifice supervened; it was stanchied by plugging the tract of the ball with pledgets of charpie dipped in a solution of persulphate of iron, and applying compresses tightly bandaged in the armpit. Bleeding recurred, and the patient died on the 12th. *Necroscopy* revealed a phagedænic condition of the posterior part of the wound, and the subscapular artery had sloughed completely through, or off, at its origin. The accompanying wood-cut (Fig. 457) represents the specimen.



Hemorrhage from the sloughing off of the left subscapular artery at its origin. Spec. 2833, Sect. I., A. M. M. (Posterior view.)

In the next case, also, the subscapular artery was invaded by the extension to it of a sloughing process, in consequence of which there occurred a secondary hemorrhage that proved fatal, notwithstanding deligation of the subclavian artery in the third part of its course:—

A soldier, aged 21,² was wounded May 9, 1864, by a conoidal musket-ball, which entered the right axilla, two and one-half inches above the lower border of the pectoralis major, and emerged two inches above the posterior fold of the arm-pit. On the 31st the right subclavian artery was tied at its outer third, for secondary hemorrhage from the injured parts, which were swollen, sloughy, and painful. The patient was feeble from

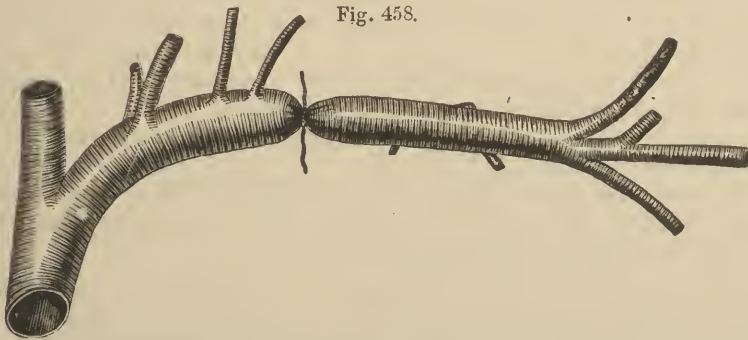


Fig. 458.

Ligature of the right subclavian artery for secondary hemorrhage; the subscapular artery had been opened by sloughing, and the ulcerous state of this vessel is shown in the cut. Spec. 4331, Sect. I., A. M. M. (Posterior view.)

loss of blood; pulse 130; skin hot. The hemorrhage, however, was not suppressed by the operation, for it recurred three times within forty-eight hours; and, on June 2, a branch of the axillary plexus of veins was tied, under chloroform, after cutting through

¹ Medical and Surgical History of the War of the Rebellion, First Surgical Volume, p. 556.

² Ibid., p. 539.

the pectoralis major muscle. But death followed three hours after the last, and fifty hours after the first operation. *Autopsy*—The subscapular artery, three-fourths of an inch from its origin, had sloughed; the axillary, and an adjacent vein, had also sloughed. The specimen is represented in the accompanying wood-cut (Fig. 458). There are anomalies in the origin of the vertebral and thyroid axis; and the axillary divides into the brachial and ulnar arteries.

We should also state that this form of after-bleeding is not unfrequently met with in parts that are involved in, and undergoing destruction from, *hospital gangrene*, and that some of the most striking instances of it ever witnessed by surgeons have occurred during the progress of that affection. The following abstract and wood-cut (Fig. 459), furnish tolerable illustrations of this point:—

Fig. 459.



Showing ligations of the radial and brachial arteries for secondary hemorrhage caused by gangrene. Spec. 3645, Sect. I., A. M. M.

A corporal, aged 37,¹ received, June 18, 1864, a gunshot flesh-wound of the upper third of the right forearm. On the 28th he was transferred to Satterlee Hospital. The wound was sloughing; the patient anæmic and despondent. Nitric acid was applied to the wound, and followed by flaxseed poultices; extra diet was prescribed. By July 20, the gangrene having ceased, healthy granulations had arisen, but the patient's despondency continued. On the 23d profuse hemorrhage from the radial artery occurred, and that vessel was ligated. The surrounding tissues being much disorganized and the hemorrhage continuing, a ligature was put around the brachial just above the bifurcation. Next day several minor hemorrhages occurred, and on the 25th the patient died, apparently of anæmic exhaustion. The specimen is represented in the accompanying wood-cut (Fig. 459), and shows the radial artery ligated just below, and the brachial artery just above, the bifurcation.

In all the cases belonging to this category, the bleeding occurs from parts of the arteries where the tunics have not been primarily injured by the missiles, as already stated. The solutions of continuity are entirely due to morbid processes of a peculiarly destructive character. These processes are much more rapid in their progress than simple ulceration. The term *sloughing ulceration* is sometimes employed to represent the less severe, and that of *sloughing phagedæna* the worst instances.

But the secondary hemorrhages which result from sloughing are specially prone to be followed by pyæmia. The accompanying abstract and wood-cut (Fig. 460) will serve to illustrate this point:—

A corporal, aged 30,² received, September 19, 1864, a gunshot flesh-wound of the middle and outer side of the left arm and left side of the back, and entered a general hospital on the 27th. The wound was then sloughing. On October 4, 5, 6, and 7, hemorrhages occurred. The first three were controlled by a saturated solution of alum and persulphate of iron, and compresses of lint. The last hemorrhage required the application of a tourniquet to restrain it; during the day the entire hand and arm became excessively congested and inflamed; the axillary artery (left) was then tied in its third part. The patient's general condition was bad; he was much debilitated, having lost in all some thirty-six ounces of blood, and was subject to intermittent

¹ Med. and Surg. Hist. of the War of the Rebellion, Second Surg. Vol., p. 450.

² Ibid., p. 442.

fever. He improved for a week, and the wound began to look healthy, when pyæmia set in. On the 22d he died, fifteen days after the operation. *Necroscopy* proved that pyæmia caused death. The right lung contained secondary abscesses, and the right

Fig. 460.



Showing the left axillary artery a fortnight after ligation for secondary hemorrhage from the brachial. Death resulted from pyæmia. Spec. 3679, A. M. M.

pleural cavity was full of pus. The specimen is represented in the accompanying wood-cut (Fig. 460). The axillary artery has been opened transversely, seemingly to show the distal coagulum.

(4) Secondary hemorrhages are not unfrequently produced by the sloughing of the coats of arteries at the points where they have been secured by ligatures. The following abstract and wood-cut (Fig. 461) will serve to illustrate this topic:—

A sergeant, aged 22,¹ received a shot wound at the upper third of the right arm June 4, 1864, the ball passing antero-posteriorly; the wound sloughed, and secondary hemorrhage ensued on the 25th; the axillary artery was ligated under chloroform. On July 1, hemorrhage arose from the axillary, the artery having sloughed at the point of ligation. The artery was then tied again high up in the axilla, by enlarging the previous wound of operation, and without anaesthesia. The patient was exsanguinated, having lost about thirty ounces of blood, and died one hour after the operation. Only the terminal subclavian and upper axillary portions of the vessel, with their branches, are represented in the accompanying wood-cut (Fig. 461).

Fig. 461.



Showing ligation of the right axillary artery in the first part of its course, for secondary hemorrhage caused by sloughing of the artery at the point where it had been ligatured for a previous hemorrhage. Spec. 2545, A. M. M. (Posterior view.)

(5) Secondary hemorrhages are sometimes produced by the liquefaction and breaking down of the coagula and adhesions which have been formed at the mouths of wounded arteries, and by which they have been more or less firmly occluded. When this retrograde metamorphosis of the fibrinous material by which the apertures in wounded vessels are, in general, permanently closed, takes place, it denotes a more or less rapidly deteriorating condition of the general health of the patient, since its occurrence is due to constitutional rather than to local causes.

¹ Med. and Surg. Hist. of the War of the Rebellion, Second Surg. Vol., p. 441.

The following example occurred in my own practice:—

A soldier, aged 27, was admitted to the Stanton Military General Hospital June 4, 1864, for a gunshot wound of the right leg, complicated with a badly comminuted fracture of the fibula, which had been received at Cold Harbor, on May 31. The effort to save the limb was continued. On June 14, secondary hemorrhage (arterial) occurred from the wound, and about ten ounces of blood were lost. The leg was then greatly swelled and inflamed all the way up to the knee. The pulse was small and frequent, and there were other signs indicating the approach of irritative fever; wherefore, the limb was amputated without delay, at the lower third of the thigh, by the circular method, under ether, as affording the patient the best chance of his life.

Examination of the amputated leg showed that the muscles were extensively infiltrated with purulent matter, that the peroneal artery was severed, and that the hemorrhage had proceeded from its proximal end, which had been re-opened through liquefaction of the occluding clot and fibrinous exudation at the mouth of the vessel.

The patient did well for a few days; but unhappily he was then seized with pyæmia, and died from that disease, eleven days after the operation.

The following abstract and wood-cut (Fig. 462) will serve to still further illustrate this subject in a useful manner:—

Fig. 462.



Showing ligation of right carotid artery, and rugose, ulcerated section of external carotid. Spec. 2133, Sect. I., A. M. M.

A soldier was wounded¹ Sept. 20, 1863, by a conoidal ball, which entered below the left zygomatic arch, passed transversely through, and escaped from the right side of the neck below the angle of the lower jaw. On Oct. 2, secondary hemorrhage from the mouth and wound of exit occurred. On the 4th the external carotid was ligated. The patient did well and appeared to be safe until the 12th, when hemorrhage recurred, but was again checked by compression. The wounds were nearly healed; but the patient was greatly enfeebled by repeated losses of blood. On the 23d profuse hemorrhage from the wound of exit again set in, and the right common carotid was ligated, about an inch and a half above its origin; but the patient sank and died on the 25th. The specimen was sent to the Army Medical Museum, and is represented in the accompanying wood-cut (Fig. 462), which shows a ligation on the common trunk, that was applied two days before death, a large coagulum at the bifurcation, but imperfectly indicated, the origins of the occipital and facial arteries from the external carotid, and the rugose, ulcerated extremity of the external carotid that had been wounded.

(6) Secondary hemorrhages are occasionally produced in the stumps of amputated limbs by the non-closure or non-obliteration of the main arteries, even when they have been properly secured by ligatures. In such cases, when a ligature separates and comes away, the blood usually flows out from the unclosed and patulous mouth of the artery in a great stream.

The following very striking example occurred in my own practice:—

A Confederate soldier, aged 27, received a gunshot wound of the right knee-joint at the Rappahannock Station November 7, 1863, and was captured. On the 9th, he was admitted to Stanton Hospital, where the attempt to save his limb was still pursued. On the 18th, however, amputation of the member became necessary, and accordingly was performed at the inferior third of the thigh, by the double-flap method, under ether. After that the patient did well in every respect until December 1, when he began to complain of great pain in the stump, and became agitated and restless. On the 2d, the pain, agitation, and restlessness were

¹ Med. and Surg. Hist. of the War of the Rebellion, First Surg. Vol., p. 393.

increased, and his countenance indicated great suffering. He referred the pain to the stump-bone, particularly the end of it; but he was not feverish, and the stump itself was not swelled nor hot. On the morning of the 3d, at an early hour, the ligature separated from the femoral artery, and secondary bleeding in a great stream immediately ensued. It was soon arrested by digital compression, and did not recur; but, meanwhile, the patient had lost so much blood that he could not be made to rally, and he died, eight hours after the separation of the ligature and the occurrence of the hemorrhage.

Autopsy.—All of the stump had firmly united by adhesion, excepting a small part around and in front of the end of the stump-bone. The end of the femoral artery was patulous, not contracted, and without evidence of any effort on the part of the reparative processes of nature to occlude it. It was embraced by the forked extremity of an osteophyte which, springing from the linea aspera, extended horizontally inward along the angle of junction of the flaps. The femoral vein was well sealed up. The medullary tissue of the stump-bone was inflamed, being dark-red in color and of firm consistence, or hepatized, and contained a great number of abscesses which varied in size from that of a pin-head to that of a split pea. This case is fully reported in the volume of U. S. Sanitary Commission Surgical Memoirs, which was prepared by the author, pp. 358, 359.

(7) Secondary hemorrhages very often occur from the distal orifices of severed or ligated arteries, and they result from the imperfect closure of these orifices, the proximal orifices being at the same time well sealed up. During our late civil war many examples of injured arteries were observed, in which there occurred during the secondary period a fatal hemorrhage from the distal end of the divided or ligated vessel. There was an occlusive coagulum on the cardiac side of the ligature; a non-occlusive coagulum, or, in some instances, even no clot at all, on the distal side. Several cases have already been mentioned in which secondary hemorrhage occurred from the distal portion of wounded or ligatured arteries. In the following example, which occurred during the late civil war, there was no clot whatever in the distal portion of the carotid artery, while the cardiac portion was securely plugged:—

Private H. Hutchins, aged 25, was wounded on December 9, 1864, by a conoidal ball, which entered the chin, fractured the lower jaw, and emerged at the back of the neck. On the 18th, violent hemorrhage occurred from the mouth; it was supposed to proceed from the lingual artery, and left the patient almost pulseless. The common carotid was ligatured just above the omo-hyoid muscle. The patient did very well until the 27th, when hemorrhage occurred in the wound of operation, from the distal portion of the artery and the deep jugular vein, and he died on the same day. *Necroscopy* showed an organized clot below the ligature; no clot had formed above the ligature, and the internal jugular vein was opened from sloughing of its tunics.¹

The clot which forms on the cardiac side of a ligature is usually much larger than that clot which forms on the distal side, and sometimes the distal clot is wholly wanting, as happened in the instance just related.

When arteries of some magnitude are wounded, and the distal ends are not tied, hemorrhage by regurgitation is very apt to occur, as was observed in the following instance of gunshot lesion of the brachial artery:—

A soldier was wounded at Fair Oaks May 31, 1862, by a ball which passed through the posterior part of the upper arm without injury to the bone, but caused an extensive ecchymosis. On June 4, he was admitted to general hospital. On the 10th, free arterial hemorrhage occurred; on removing the clots, the wounded parts were found extensively disorganized, and the brachial artery not accessible. The axillary was then tied high up, and the subscapular also, to prevent subsequent trouble. On the 21st both ligatures came away; feeble pulsations in the radial artery were observed. On the 23d very profuse hemorrhage from the brachial again occurred, which was stopped by compres-

¹ Medical and Surgical History of the War of the Rebellion, First Surg. Vol., p. 420.

sion applied with a pad in the axilla. On July 12 and 13, troublesome hemorrhages still again occurred, and on the 14th the patient died.¹

The return of pulsation at the wrist showed how completely the circulation in the arm had been restored; two days afterwards, that is, as soon as the tension in the brachial artery was sufficiently strong to expel the clots at the wound, they were pushed out, and then the blood regurgitated freely through the distal portion of the artery into the wound, and a very profuse hemorrhage ensued.

The following example serves well to illustrate the difficulties in treating hemorrhage from wounds of the shoulder, which are sometimes encountered in practice:—

Lieutenant-Colonel Dawson, aged 38, received, June 17, 1864, a gunshot flesh-wound of the left shoulder. The bullet was extracted, and on the 19th he was sent to general hospital at Washington. On the 27th, secondary hemorrhage to the amount of thirty ounces supervened. The operation of tying the axillary artery was resorted to, but the bleeding still continued. The distal extremity was then secured by tying the brachial artery. A few hours later, however, the hemorrhage burst forth afresh, and finally the patient died.²

In this case the ligature of the brachial stopped the bleeding for a time by arresting the regurgitation of blood in the brachial artery. From what vessels did the blood escape which finally destroyed this patient? Clearly not from the axillary artery above, nor from the brachial artery below, the points where the ligatures were applied. But a long stretch of the main artery, embracing its wounded part, lay between these two points, and from this some five or six important branches were sent off, namely, several of the thoracic branches, the subscapular, the two circumflex arteries, and the superior profunda; and the hemorrhage which destroyed this patient was doubtless caused by regurgitation of blood through these branches into the main trunk, whence it readily escaped by means of the wound. This result could have been obviated by tying the main artery at the spot where it was injured, with two ligatures, one of them being applied on each side of the aperture in its walls. The axillary artery, therefore, whenever it is the source of secondary hemorrhage, must always be tied in the wound with ligatures placed on each side of the breach in its walls, and in close proximity thereto. When promptly treated in this manner, these hemorrhages give no further trouble.

TREATMENT OF SECONDARY HEMORRHAGE.—The *prophylaxis* of secondary hemorrhage demands that all wounds, whether the result of accident or of surgical operations, but more particularly those which involve bloodvessels, shall be kept free from purulent matter, by antiseptic treatment and thorough drainage, especially the latter. Otherwise, ulceration and sloughing of the arterial and venous tunics, together with softening and disintegration of the occluding coagula, are very liable to supervene, and secondary hemorrhage to ensue. The following abstract and the wood-cut accompanying it (Fig. 463) illustrate in a useful manner the disastrous consequences which may follow the retention and burrowing of pus in wounds made for the deligation of the common carotid artery:—

A sergeant, aged 21,³ was wounded Aug. 25, 1864, on the field, by a musket-ball, which entered over the right mastoid process, injured the external ear, and lodged under the

¹ Med. and Surg. Hist. of the War of the Rebellion, Second Surg. Vol., p. 443.

² Ibid., Second Surgical Vol., p. 442.

³ Ibid., First Surg. Vol., p. 393.

skin, a little in front of the auditory foramen. On the 28th he entered the Lincoln Hospital at Washington. The ball had not been extracted, but no symptoms demanded special attention until Sept. 7, when it was observed that the right parotid gland was so greatly inflamed that the patient could with difficulty separate his teeth more than one-fourth of an inch. In the course of the day, an alarming hemorrhage, supposed to proceed from the posterior auricular artery, occurred; it was stopped by compression with lint steeped in a solution of persulphate of iron. On the 9th, an alarming hemorrhage again occurred, which was temporarily arrested, with difficulty, by compression with lint and styptics, until the patient could be taken to the operating room, where, under ether, the right common carotid artery was tied. Coagula were removed, and the missile was extracted from near the angle of the jaw. The bleeding recurred on the 11th and 12th, but ceased spontaneously. On the 18th, there were several recurrences of hemorrhage. On the 19th, the ligature was removed; the face and neck were much swollen. On the 20th, the patient died from hemorrhage. *Autopsy*—Submaxillary gland suppurating; an abscess extended about three-fourths of an inch above and below the place of ligation, and the ends of the artery were covered with pus. The artery from which the hemorrhage issued was not found. The specimen was sent to the Army Medical Museum, and is represented in the accompanying wood-cut (Fig. 463) which shows the termination of the innominate, the commencement of the right subclavian, the trunk of the right common carotid, severed by ulceration at the site of the ligature, and the bifurcation into the external and internal carotid, the calibre represented being one-third of the normal. The ligature on the internal carotid was applied during an experiment upon the cadaver.

Fig. 463.



It is not improbable that, in cases like the above, the patient might often, perhaps generally, be saved by the employment from the very outset of antiseptic dressings and thorough drainage.

The use of carbolized catgut, or other appropriate antiseptic animal ligature, for the deligation of arteries and veins, will likewise aid much in producing good results, because it does not, in general, cause ulceration, but more or less slowly disappears by absorption, without inducing suppuration; and for this reason such ligatures should be applied in all deligations, whether performed in the primary, intermediary, or secondary period. When suitable animal ligatures are not at hand, those of carbolized silk should be employed, as has already been stated.

Many of the examples presented in the foregoing pages, with a view to illustrate the *pathogenesis* of secondary hemorrhage, also very clearly show some things which should *not* be done for that affection.

(1) The wound should not be plugged with lint soaked by acid ferric salts, or any other so-called styptics, for this treatment never permanently suppresses the bleeding where vessels of any magnitude are opened, and it often does much harm, by permitting the hemorrhage to return again and again in cases where the greatest promptitude of action on the surgeon's part is necessary, in order to prevent the loss of so much blood that fatal anæmic exhaustion must ensue.

(2) The main artery should not be tied at a distance from the bleeding wound, unless nothing else can be done, for in a large majority of cases where arteries are ligatured on the plans of Anel and Hunter, for secondary hemorrhage from open wounds, the bleeding returns sooner or later, and proves fatal.

But how should secondary hemorrhages be suppressed? In the first place,

Showing ulceration of the common carotid attending the separation of a ligature on the tenth day; death from hemorrhage on the following day. Spec. 3252, Sect. I., A.M.M.

the wound must be opened, and the aperture whence the blood issues from the injured vessel must, if practicable, be exposed to view by enlarging the original wound or by making fresh incisions, if necessary, and by wiping out the coagula. Oftentimes the search can be materially aided by having an assistant control the flow of blood in the main artery by digital compression, especially in the extremities, and sometimes, likewise, in the neck. "Look your enemy fully in the face," is a motto still more applicable to the management of external hemorrhages than to behavior in battle, for the surgeon has no long-range weapon with which to overcome his adversary. The bleeding vessel having been brought into view, it must be secured with two ligatures, one of them being applied on each side of the aperture in its walls, or to each end of the vessel, if it be completely divided; and the surgeon must sever the artery midway between the two ligatures, with a knife or scissors, in all cases where the original injury has not done so, in order that the two ends may retract, and thus lessen the tendency to a return of the hemorrhage.

The bleeding vessel should likewise be sought for and found without any delay, to the end that infiltration of the surrounding textures with extravasated blood may be avoided, and that the hemorrhage itself may be permanently stopped, if possible, before the loss of blood becomes so great as to cause death by anæmic exhaustion, days and perhaps weeks afterward. The bleeding from small vessels will generally cease on exposing them to the air by wiping off the coagula, and applying cold water with moderate pressure. But to all vessels which continue to bleed, both proximal and distal ligatures must be applied.

When the hemorrhage proceeds from an artery that is inaccessible, as, for instance, the internal maxillary, the main trunk should be tied as near the injured part of the vessel as practicable. In cases where the hemorrhage proceeds from branches of the external carotid which cannot be tied in the wound, the external carotid itself should be ligatured, rather than the common carotid. But the superior thyroid, facial, temporal, and occipital, should always, if possible, be ligatured at the place of injury. Hemorrhage from wounds of the tongue involving branches of the lingual artery should be combated by tying the trunk of that artery above the great cornu of the hyoid bone; and, owing to the great freedom of inosculation across the median plane, it will often be necessary to tie both linguals or both external carotids.

When the vertebral artery is found to be the source of the bleeding, it should be secured by proximal and distal ligatures, if the seat of injury be below the foramina in the transverse processes of the cervical vertebrae; but if the artery be wounded above its passage into these foramina, it should be plugged with a piece of agaric, or a wad of lint, so fashioned as to completely fill the calibre of the artery, on the distal as well as on the proximal side of the breach in its walls.

When an artery of the axilla is found to be the source of the hemorrhage, it should be borne in mind that there is scarcely any other region of the whole body where it is equally important to bring the bleeding vessel into view and to tie it on each side of the gap in its walls. If the axillary artery itself be found wounded, and the circulation be controlled by compressing the subclavian against the first rib, the distal ligature should always be applied first; otherwise, the profuseness of the distal bleeding will very much delay the completion of the operation, and perhaps place the patient's life in peril.

In operating for secondary hemorrhage in the extremities, both lower and upper, it should never be forgotten that the application of a distal ligature is just as important as the application of a proximal ligature, because of the great freedom with which the terminal branches in the extremities inosculate together, as Dupuytren was the first to point out.

Secondary hemorrhage from small arteries in deep cavities, where ligatures cannot readily be applied, may be suppressed by applying the actual cautery.

The employment of carbolized catgut ligatures, antiseptic dressings, and thorough drainage by means of tubes of appropriate size, has already been insisted on with sufficient energy.

PARENCHYMATOUS HEMORRHAGE:

This form of bleeding did not receive mention until a very recent period. No account of it whatever is given by Guthrie, Hennen, or their predecessors. Stromeyer appears to have been the first to call attention to it.

In cases of parenchymatous hemorrhage, the blood does not issue from the wounded, granulating, or ulcerating part in distinct streams, but seems to escape by a general oozing through minute apertures. We therefore infer that the capillaries constitute its anatomical source, and that it is in reality a capillary hemorrhage. In such cases the blood flows in a steady stream. It does not in general possess the purple hue of venous, nor yet the bright-red color of arterial blood. It is in general not as dark as the former, nor as bright as the latter. It therefore usually has a distinct color of its own, and this, conjoined with the flow of the escaping blood in a steady stream, has led me to correctly surmise, in some instances where these phenomena were present, that the hemorrhage was parenchymatous in character, before the interior of the wound from which it issued had been exposed to view.

Parenchymatous hemorrhage has been met with in the *primary*, the *intermediary*, and the *secondary* periods in the history of wounds; but the causes or pathological conditions upon which its occurrence depends are, for the most part, widely different in each of these periods, especially in the primary and secondary periods.

Parenchymatous hemorrhage has been encountered during the *primary period* in the stumps of limbs just amputated, where the operation has been performed through tissues that had previously been inflamed, and in which the inflammatory process had not yet entirely subsided. Such a hemorrhage is due to the fact that the dilated capillaries which have been severed by the knife in performing the operation, being still paralyzed from the inflammatory process, are unable to close their open mouths by the contraction of their muscular tunics, and that therefore the hemorrhage continues without impediment until it is suppressed by surgical art or by the occurrence of syncope, or until death occurs.

Parenchymatous hemorrhage has been met with during the *intermediary period* in cases of amputation where the mouths of the capillaries have been but feebly or imperfectly closed in the primary period, so that when reaction has come on, with the vascular excitement and increased blood-pressure which attend it, the capillary orifices have been reopened, and capillary hemorrhage has ensued. In such cases, more or less parenchymatous bleeding usually attends the operation itself, and, occasionally, the capillary oozing continues in a minor degree until the advent of the intermediary period, when the capillary bleeding becomes more and more copious as the vascular excitement rises higher and higher.

When parenchymatous hemorrhage occurs during the *secondary period*, it is generally associated with the symptoms of pyæmia, or, at least, with pyæmoid phenomena, and is caused by obstruction of the veins which proceed from the seat of the hemorrhage toward the heart, with coagulated blood or *thrombus*, as was pointed out by Stromeyer. The state of affairs, as far as the circulation of blood is concerned, in a wounded limb, the principal veins of

which are occluded by *thrombosis*, is as follows: The blood injected into the limb through its arteries, being not conducted away through its veins, stagnates, and exhibits a more or less strong tendency to effuse itself from the parts whose capillaries are not strengthened and supported by tissues exterior to their walls. Thus it happens, in such cases, that the capillaries of wounded, granulating, and ulcerating surfaces, not unfrequently give way in consequence of the increased vascular tension, and parenchymatous hemorrhage ensues.

To illustrate *primary parenchymatous hemorrhage*, the following example, which occurred in my own practice, is presented:—

Lieut. C. H. Doerflinger, Co. K, 26th Wisconsin Vols., aged 20, and of excellent constitution, was wounded at Chancellorsville, May 2, 1863, by a conoidal musket-ball, which fractured his left leg, etc. On June 15, he was brought to Stanton Hospital, where the effort to save his limb was continued, although his condition was not favorable. On the 27th, amputation could no longer be delayed, and accordingly it was performed at the lower third of the thigh by the circular method. At the place of operation the tissues were considerably swelled and inflamed. A large number of ligatures were applied. There was also a troublesome oozing of blood, a parenchymatous hemorrhage, from the face of the whole stump. After a time the wound of operation was closed and dressed; but the patient was still retained upon the operating table. In a little while, I was recalled because of a profuse flow of blood through the dressings. These were immediately removed, and the stump opened, in order to find the source of the hemorrhage. It was then seen that the blood did not issue in a distinct stream at any point, but escaped from the parenchyma over the raw surface of the whole stump, by a process of general oozing, and that the hemorrhage in all constituted a current of considerable size. The application of cold water, and even of ice, did not arrest this parenchymatous bleeding, and seemed to retard it but little. Finally, I covered the whole surface of the stump with lint soaked in liquor ferri persulph., and this proceeding speedily suppressed the bleeding. The stump was left open so as to granulate from the bottom, and prevent any collection of purulent matter. The patient slowly recovered.

Another example of primary parenchymatous hemorrhage, which occurred in my own practice, may be found reported in the volume of the U. S. Sanitary Commission Surgical Memoirs, that has been already referred to.¹

Dr. W. Clendenin has reported a case of primary parenchymatous hemorrhage in a thigh-stump, which proved fatal:—

B. F. Black, Co. A, 6th Kentucky Infantry, aged 23, was wounded at Chickamauga September 19, 1863, by a ball which passed obliquely through his right knee-joint. On October 30, amputation of the limb was performed. No tourniquet was used, and yet, after securing the arteries, profuse hemorrhage of a parenchymatous character took place. This hemorrhage was of the most persistent character; it was, however, finally arrested by applying a strong solution of persulphate of iron, but not until such a quantity of blood had been lost that death ensued the same evening.

Autopsy.—In the stump, a large abscess extended as high as the trochanter major, the intermuscular spaces being filled with a sero-purulent fluid. In the femoral vein, just below Poupart's ligament, a fibrinous clot was found, which completely filled up the venous canal at that point. No pus was seen here, nor in any of the veins. The right side of the heart was entirely filled with a fibrinous clot. The liver, lungs, and all other organs were sound.²

The femoral vein, in this case, was occluded by a *thrombus*, whose formation had resulted from the presence of an unhealthy femoral abscess. The parenchymatous bleeding which followed the amputation had, therefore, a twofold origin: *First*, the inflamed condition of the tissues divided by the

¹ Op. cit., pp. 241, 413, 414.

² Ibid., pp. 241, 242.

operation, and the dilatation and paralysis of the capillaries which attend that condition; *Secondly*, the obstruction to the flow of blood from the stump toward the heart, which was caused by the fibrinous plugging or *thrombosis* of the femoral vein. We must, therefore, count thrombosis among the possible causes of primary parenchymatous hemorrhage; and its presence will always make the prognosis very unfavorable.

To illustrate *intermediary parenchymatous hemorrhage*, I shall again call attention to the case of Lieut.-Colonel Maxwell, already presented under the head of Intermediary Hemorrhage. The bleeding occurred in a thigh-stump on the second day after a secondary amputation. It was suppressed by opening the stump, and painting its raw surface all over with liquor ferri persulph. fortis, by means of a camel's hair brush. The patient recovered. Another example of intermediary parenchymatous hemorrhage may be found in a case of secondary amputation of the left arm at the shoulder-joint, performed on August 5, 1864. Hemorrhage to the extent of eight ounces occurred on the 6th. The stump was then opened; "blood apparently oozing from the tissues, and was checked by pressure and Monsel's salt." The patient's general condition was very low, and two days afterwards he died.¹

To illustrate *secondary parenchymatous hemorrhage*, the following abstract of a case, which occurred in my own practice, is offered:—

Private B. Romig, Co. F, 6th Michigan Cavalry, received on September 23, 1863, a gunshot flesh-wound of the right thigh, at the middle third, and on the inner side. The missile penetrated deeply, and lodged. On the 25th, he was admitted into Stanton Hospital. On October 11th, the symptoms of pyæmia appeared; and, on the 23d, the wounded limb was observed to be œdematous. On the 25th, while the patient was sitting on a chair to have his bed remade, hemorrhage from the wound suddenly occurred to the extent of four or five ounces, and ceased spontaneously. On the 26th, the hemorrhage recurred, and three or four ounces of blood were lost before it again ceased spontaneously. Meanwhile pyæmic rigors appeared, and frequently returned. The patient rapidly failed, and died about three o'clock P. M. on the 26th.

Autopsy.—Right lower extremity much swelled and œdematous; on laying open the thigh and groin by incisions along the course of the femoral and iliac arteries, the chain of lymphatic ganglia was found to be very much enlarged in all its component parts. The femoral and other arteries were sound. But the right common iliac, external iliac, common femoral, and deep femoral veins were filled with coagulum (*thrombus*), which in some parts exhibited a quite recent appearance, but in others was more or less disintegrated and softened by fatty transformation. The walls of the thrombosed veins were likewise very much thickened. The thrombosis had obviously caused the hemorrhage.

Not long afterward, another striking example of secondary parenchymatous hemorrhage came under my care at the same hospital:—

Tobias Beaver, a prisoner of war, aged 30, was admitted on November 9, 1863, for a gunshot fracture of the left femur in its lower third, which had been received on the 7th. After some time, the fracture united and the wound of the soft parts healed. At a still later period, osteo-myelitis supervened, in consequence of the lodgment of a part of the missile in the medullary canal. The wound then reopened, and the general health became much impaired. On March 23, 1864, some hemorrhage from the wound occurred. The patient was weak, pale, and anæmic. On the 25th, he had a severe hemorrhage, which was controlled externally by injecting liquor ferri perchloridi; but the thigh swelled rapidly from internal effusion of blood. On the 27th, he died.

Autopsy.—The thigh was swelled to twice the normal size. It contained a cavity which extended from the synovial pouches of the knee-joint to the trochanter major, and was full of blood and pus, the quantity being estimated at one quart; the external outlet of this cavity was plugged by a hard coagulum. The superficial femoral vein

¹ Medical and Surgical History of the War of the Rebellion. Second Surgical Volume, p. 444.

was filled with coagulated blood (*thrombus*) from the popliteal to the mouth of the profunda. The subcutaneous connective tissue was highly œdematous, this œdema, as well as the hemorrhage, being obviously due to the obstruction of the venous circulation.

Three additional examples of secondary parenchymatous hemorrhage, which came under my own observation, are reported in the volume of U. S. Sanitary Commission Surgical Memoirs, already referred to.¹

We have thus mentioned five cases in which parenchymatous hemorrhage occurred during the secondary period. In all of them the bleeding was preceded by general debility, pallor, and loss of flesh. All of them proved fatal. In three instances, the veins were examined after death, and their condition noted; in every instance, the principal veins leading from the seat of the parenchymatous bleeding were found perfectly occluded by coagulated blood, that is, they were plugged up by *thrombosis*. In the remaining two instances, doubtless, the veins were also plugged up by blood-clots. In every one of the five cases, likewise, there were more or less strongly marked symptoms of pyæmia.

To the *obstructive* form of secondary parenchymatous hemorrhage, just described, there is another of some importance which must be added. Capillary hemorrhages may be produced on the surface of granulating wounds by powerful stimuli to the vascular and nervous systems of any kind, as, for instance, venereal excitement, and excess in drinking. The first-named is the common, and the latter an occasional, cause of this additional form of parenchymatous bleeding, which may occur during the secondary period in the history of wounds or surgical operations.

SCORBUTIC PARENCHYMATOUS HEMORRHAGE.—Scurvy essentially consists of an alteration in the constitution of the blood, which leads to an effusion from the capillaries into the various tissues of a fibrinous liquid, usually deeply colored by red corpuscles.

The passive hemorrhages which take place from the gums, nose and ears, stomach, and bowels, and occasionally from the lungs and bladder, in cases of scurvy, are usually capillary hemorrhages.

The sanguinolent effusions on the free surfaces of sores or ulcers, which impart to them the peculiar aspect termed "scorbutic," are also poured out from the capillaries, and therefore they appear to ooze out from the parenchyma at the base and margins of these sores or ulcers.

When scorbutic persons are wounded, the more or less copious oozing of a sanguinolent liquid from their wounds, or parenchymatous hemorrhage, is not uncommon in the primary, the intermediary, and the secondary periods, but especially in the first two of these. Boyer relates a case where it occurred in the secondary period:—

I amputated (he says) the middle finger of a man, aged 50, for caries in consequence of whitlow. The collateral arteries were tied; the ligatures came away on the seventh day; no hemorrhage followed. Shortly afterward, however, the lips of the wound became bloated, black, soft, and spongy, and bled freely on the slightest touch. From this time the patient experienced every day considerable hemorrhage, to which the ligature and compression were opposed in vain. The bloated appearance of the wound, the spongy state of the gums, the violet spots which appeared on several parts of the body, especially the legs, left no doubt of the existence of scurvy. The patient was then placed upon a strongly antiscorbutic plan of treatment; the hemorrhage soon ceased, and he rapidly recovered.

¹ Op. cit., 245-248.

TREATMENT OF PARENCHYMATOUS HEMORRHAGE.—The primary and intermediary forms of parenchymatous hemorrhage can almost always be promptly suppressed by applying the solution of the persulphate or the perchloride of iron to the bleeding surface, by means of a camel's hair brush, or a piece of lint, as already shown above. In the absence of these styptics, it is highly probable that the primary and intermediary forms of parenchymatous hemorrhage, in open wounds, may be arrested by the application of hot water to the bleeding surface. To be of use the water must be hot enough to coagulate albumen, that is, its temperature must be not less than 160° Fahr. Should this proceeding fail, the actual cautery may be necessary.

When parenchymatous hemorrhage occurs in the secondary period, in consequence of thrombosis and pyæmia, there is but little hope of saving the patient. If the application of styptics and pressure does not stop the hemorrhage, the surgeon may amputate the bleeding member, or tie its main artery. Upon this point Stromeyer says: "A single amputation, practised on this account, proved rapidly fatal; the ligature of the chief artery had but temporary success; the extraction of extensive loosened sequestra sometimes effected a temporary stoppage of the hemorrhage, but death followed from pyæmia."¹ The results of my own experience in this regard are no better. In some cases, doubtless, it is preferable to amputate; in others, to tie the main artery. If the patient be not already much reduced by systemic disease, and especially if pyæmia has not yet appeared, it is better to amputate; but if the patient be very low, or affected with pyæmia, it is better to ligature the main artery.

When parenchymatous hemorrhage results from venereal excitation or excess in drinking, the bleeding may be promptly suppressed by the application of iced water or of the acid salts of iron, in solution, to the part whence it proceeds. The main point, however, in the treatment of such cases, is to prevent a recurrence of the hemorrhage by meeting the causal indication, that is, by removing or making inoperative the causes which produce it.

Scorbutic parenchymatous hemorrhage must be treated by freely administering antiscorbutic remedies, such as the juice of scurvy-grass, limes, and lemons, together with acidulous fruits and fresh vegetables for food, as well as milk and the juice of raw beef.

DELIGATION OF ARTERIES.

The instruments required for the ligation of arteries or veins, in their continuity, are a scalpel, forceps, grooved director, silver probes, artery-needles, and ligatures.

The ordinary scalpel (Fig. 464) is best adapted to the dissection, and the



broad, thin, end of its handle can be employed to separate the connective tissue, the layers of fascia, and other parts, where it is not desirable to use the cutting edge. The forceps (Fig. 465) should have delicate, accurately-fitting teeth, and the blades, while not too broad, should be so stiff as not to bend when closed and locked, on making traction. Not unfrequently, a second

¹ Gunshot Fractures, p. 35, Am. ed., 1862.

Fig. 465.



Liston's artery forceps.

pair of forceps is also required. One, at least, of the silver probes (Fig. 466) should have a flattened and eyed extremity.

Fig. 466.



Silver probes.

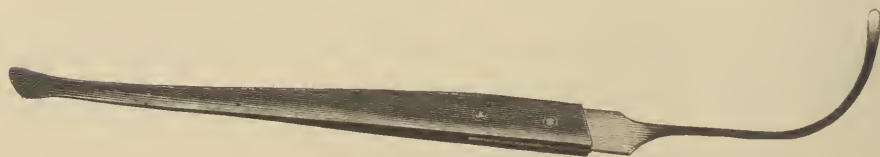
Of artery-needles, among the best is Mott's "American aneurism needle" (Fig. 441, p. 690), especially for ligaturing deeply seated arteries. It consists of two sections, namely, a straight handle and a curved extremity, the latter of which is screwed on to the former. The curved extremity, or point of the needle, has two eyes; when used, the second eye is threaded with the ligature; the point of the needle is then gently passed under the artery, and, as it emerges on the opposite side, the blunt hook is inserted into the first eye, whereby the point is securely held until the handle is unscrewed, when the point is drawn through with the ligature. There are, however, several forms of artery-needle which may be reckoned as useful instruments; three of them are represented by the accompanying wood-cuts (Figs. 467, 468, 469).

Fig. 467.



Plain American aneurism needle.

Fig. 468.



Syme's aneurism needle.

The curved point of Mott's artery-needle is sometimes liable to become loosened, and may then turn in the wound while it is being passed around the artery. To obviate this difficulty the instrument represented by Fig. 469 has been devised. The shaft is hollow, and receives a steel rod, having a button-shaped head for convenience in turning it. The lower end of the rod terminates in a male screw, destined to work in a female screw in the upper end of the curved point. The shaft is provided at its lower end with two triangular teeth, and the upper end of the curved point with two correspond-

ing triangular depressions, as shown in the drawing. The two parts of the instrument being placed in relation with each other, the screw is projected,

Fig. 439.



Improved American aneurism needle.

and two or three turns effectually lock the parts together. After the point of the needle has been passed under the artery, and while it is held by the hook, two or three reversed turns of the screw disengage the curved extremity containing the ligature, with which it is then drawn through.

For ligatures, carbolized catgut, prepared by Mr. Lister's improved method, is preferable to every other kind of thread. When from want of suitable animal ligatures it is necessary to use silk ones, they should be carbolized by soaking them for half an hour in a mixture of melted wax and carbolic acid.

The patient must be placed upon a firm bed or upon a table, and the surgeon takes a position usually on the outer side of the limb or part to be operated on; one assistant administers the anæsthetic, a second assistant takes a position where he can compress the artery on the proximal side, if by any accident it should be wounded, or if the ligature should cut through its tunica; a third uses the sponges, and a fourth manages the retractors.

It is important to guard against wounding the superficial veins; wherefore their position should be defined before commencing the operation, which can readily be done by applying pressure on the cardiac side of the point at which the incision is to be made.

GENERAL RULES FOR EXPOSING AND LIGATING THE PRINCIPAL ARTERIES IN THEIR CONTINUITY.—I. The operator must, before commencing the operation, call to mind the exact anatomical relations of the parts involved in the operation.

II. The direction and length of the cutaneous incision is then to be determined. It is expedient to mark this out upon the skin with ink or chalk.

III. The body is brought into the position most advantageous for the operation, and into the best light.

IV. The *cutaneous incision* is made by keeping the skin upon a stretch with the fingers of the left hand, while the scalpel cuts through the whole thickness of the skin from one end of the incision to the other; or, if the artery lie immediately under the skin, by pinching up a transverse fold thereof with the fingers, and cutting it through with one stroke of the knife, either from without inward, or by transfixion from within outward.

V. Pinch up the *fascia* carefully with the forceps, nick it with the scalpel applied horizontally, and incise it freely on a grooved director introduced beneath.

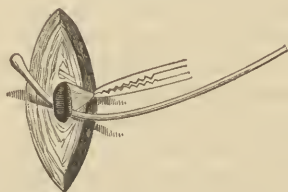
VI. After the edge of the *muscle* is laid bare, which is the *anatomical guide* to the artery, very little use should be made of the knife. With his fingers, or the handle of the scalpel, the surgeon can readily separate the connective tissue so as to fully expose the sheath of the artery; and by so doing he will be much less troubled with oozing of blood or hemorrhage from small vessels, and be enabled to see the principal artery much more distinctly, than if he should use the knife in the deep parts of the wound. (Mott.)

VII. As soon as the *sheath of the artery* is exposed, the operator seizes it with his forceps and raises it into a small cone. He lowers the handle of his

knife so far sidewise and outward that the flat surface of the blade is turned toward the artery, and then divides the cone, flatwise, just beneath the forceps, thus opening the sheath of the vessel. By repeating this procedure, he can open the arterial sheath to any desirable extent. But denuding the artery to any considerable extent of its filamentous structure, must, by robbing the vessel of its connecting media, always be adverse to reparative changes. In fact, if the artery be detached too far from its sheath, it will be liable to slough, and secondary hemorrhage to ensue at the seat of ligation. The sheath should, therefore, be opened no further than is necessary to permit the needle to enter it and pass around the vessel.

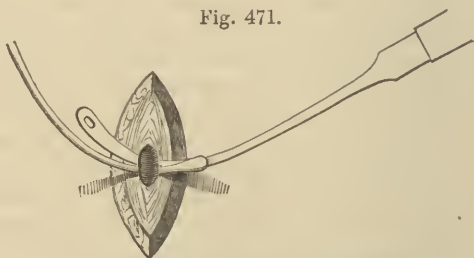
VIII. As soon as the sheath is sufficiently opened, Mott's or the improved American aneurism needle is introduced, and carefully passed around the artery, but always from the side where the vein lies; the handle is then detached by unscrewing it, and the curved point together with the ligature is drawn through. Or, a bent probe is carefully passed around the vessel whilst a pair of forceps keeps the sheath upon the stretch (Fig. 470).

Fig. 470.



Introducing the probe. (Esmarch.)

Fig. 471.



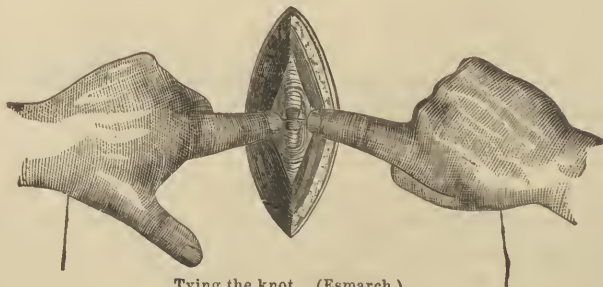
Introducing the aneurism needle. (Esmarch.)

IX. By means of the probe, a track is made, through which a narrow aneurism needle (Syme's or the plain American needle), with an eye at the point, is passed in an opposite direction (Fig. 471).

X. The probe is then removed; the eye of the needle being threaded with a strong ligature of carbolized catgut or carbolized silk, the needle itself is withdrawn, and the middle of the ligature remains lying beneath the artery.

XI. The ends of the ligature are tied together with a square or reef knot, and without pulling on the artery. The knot must be drawn together with the tips of both index fingers at the bottom of the wound (Fig. 472).

Fig. 472.



Tying the knot. (Esmarch.)

XII. It is advisable to tie the larger arteries with two ligatures, and to divide the vessel itself midway between them, so that both ends may retract within the sheath.

LIGATION OF THE INNOMINATE ARTERY.—*Surgical Anatomy.*—The innominate is the first and largest of the great branches which issue from the arch of the aorta. In length it varies from one inch and a half to one inch and three-fourths. It arises from the right superior portion of the arch of the aorta, in front of the left carotid, and passes in an oblique direction upward, outward, and backward, to the superior margin of the right sterno-clavicular articulation, where it divides into the right common carotid and right subclavian. By extending the neck, the innominate can be drawn up and made more superficial.

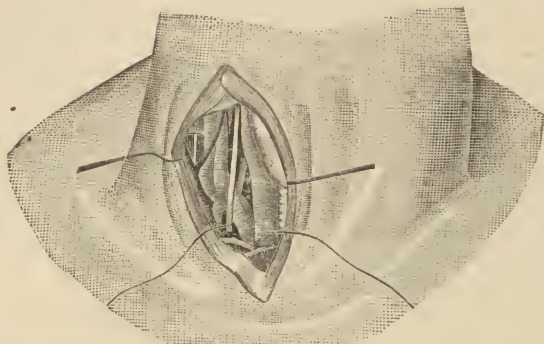
It is in relation on its right side with the right vena innominata, right pneumogastric nerve, and the summit of the right pleura; on its left side, with the left carotid artery and a remnant of the thymus gland; behind, with the trachea; in front, with the inferior thyroid vein and the left vena innominata, a remnant of the thymus gland, the origins of the sterno-thyroid and sterno-hyoid muscles, and the sternum.

Mott's Operation.—Place the patient on his back, with his shoulders slightly raised, his head well thrown back, and his face turned to the left side. The operator, standing on the patient's right side, makes an incision two and one-half or three inches long, half an inch above and parallel to the top of the sternum and the inner part of the right clavicle, through the skin, superficial fascia, and platysma myoides, commencing over the trachea, and ending over the sterno-cleido-mastoid muscle. Another incision of the same length is then to be made along the anterior border of the sterno-mastoid muscle, until it joins the first where it began over the trachea, at the middle line. The sternal root and most of the clavicular root of the sterno-cleido-mastoid muscle are next separated by a director from the underlying fascia, and then divided by cutting in the line of the first incision, using a finger passed under the muscle as a guide. The angular flap must be turned outward. Pushing the thyroid veins aside, the sterno-hyoid and sterno-thyroid muscles are now to be carefully raised on a director, cut across, and drawn inward. A little scratching with a probe or handle of the scalpel will disclose the sheath of the common carotid artery, pneumogastric nerve, and internal jugular vein. Next open the sheath of the carotid, and trace the artery downward to the innominate. Separate the pneumogastric nerve from the carotid, draw it with the internal jugular vein outward, and the carotid inward, toward the trachea, and expose the subclavian artery. In uncovering the innominate, the utmost pains must be taken to avoid injuring the right and left innominate veins. Pass the needle from below upward and inward, taking especial care to avoid wounding the pleura.

Dr. Valentine Mott, of New York, who was the first to ligature the innominate, operated by the method just described, in May, 1818. The patient, however, died on the twenty-sixth day from secondary hemorrhage.

Sédillot's Operation.—The brachio-cephalic trunk (says Sédillot) can very easily be reached by following another procedure which I have applied to that artery (Fig. 473), to the primitive carotid, to the commencement of the subclavian, and to the principal branches which issue from it, such as the inferior thyroid and the vertebral. To execute this procedure, make an incision two inches and a half or three inches in length through the integuments, along the interval which separates the sternal and clavicular attachments of the sterno-cleido-mastoid muscle. This interval is distinctly marked by a depression above the sterno-clavicular articulation. Separate the internal from the external portion, while the head is slightly flexed in order to relax the muscle; then, by turning over the sterno-hyoid and sterno-thyroid muscles inside, or by dividing them on a grooved director, which is preferable, one can perceive at the bottom of the wound

the innominate, the common carotid, the pneumogastric nerve, and its branch the recurrent laryngeal; and more externally and above, the phrenic nerve,

Fig. 473.¹

Showing Sédillot's method of tying the innominate artery. (Sédillot.)

the internal jugular vein, the trunk of the subclavian, and the origins of the vertebral, inferior thyroid, and internal mammary arteries.²

This procedure enables the surgeon to judge of the condition of the vessels on which he operates, to modify his manœuvres according to their pathological state, and to expose, ligate, and divide between the two ligatures one or several arteries, to assure the success of his operation.

Fig. 474.



Showing Manec's plan of tying the innominate artery. (Sédillot.)

Manec's Transverse Operation.—Make an incision 9 centimetres ($3\frac{1}{2}$ inches) in length, extending from a point midway between the two sterno-mastoid muscles, toward the right shoulder, $1\frac{1}{2}$ centimetres, (about $\frac{3}{8}$ inch) above the clavicle (Fig. 474), through the skin and platysma myoides; then, on a grooved director, divide the sterno-mastoid as far as the incision extends, and likewise, successively, the sterno-hyoid and sterno-thyroid. Isolate the innominate artery with the handle of the scalpel and the director, taking care to avoid the internal jugular vein, and the pneumogastric and phrenic nerves.³

Appreciation.—The procedures of Sédillot and Manec may appear to be more brilliant; but when we consider the difficulty of performing such an operation during life, and the obstacles caused by the effusion of blood at the bottom of a narrow wound, into which the instruments are with difficulty introduced, we shall recognize, I believe, that Mott's operation is the most prudent and

¹ Permission to copy this wood-cut and many others that follow it, to which his name is attached, has been generously given to the writer by Professor Sédillot, Member of the Institute, etc., for which courtesy it is but just to make this acknowledgment.

² Médecine Opératoire, t. i. pp. 240, 241. Paris, 1865.

³ Ibid., pp. 241, 242.

the most sure, and that it should therefore be preferred. This, too, is Sédillot's opinion. [The innominate artery appears to have been tied in 25 cases, including that recently recorded by Durante. The result of this has not been determined, but the rest, with two exceptions (the cases operated upon by Dr. Smyth and Mr. Banks), all proved fatal. Banks's patient died after subsequent ligation of the subclavian.]

Dr. Smyth ligatured the innominate one-fourth of an inch below its bifurcation, for traumatic aneurism of the subclavian, tying also the common carotid one inch above its origin. Hemorrhage occurred on the fifteenth, thirty-third, and fifty-first day, and was controlled in each instance by filling the wound with shot. On the fifty-fourth day the bleeding again recurred, and then the vertebral was tied; after that, the case progressed, without interruption, to complete recovery. [The patient survived ten years, ultimately dying of hemorrhage from the aneurismal sac, into which the blood had made its way through the subscapular artery.]

LIGATION OF THE COMMON CAROTID ARTERY.—This artery was first tied for aneurism by Sir Astley Cooper, in a woman, aged 44, at Guy's Hospital, in 1805.¹ The patient died, however, on the nineteenth day. The same surgeon repeated the operation, in 1808, with success.

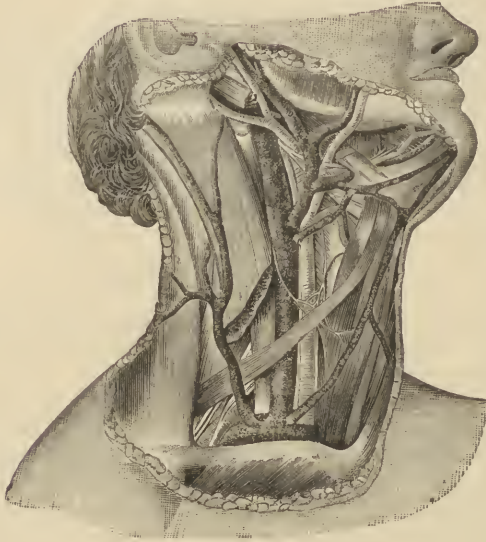
Surgical Anatomy.—The right common carotid artery extends from the innominate, that is, from the right sterno-clavicular articulation, to the upper edge of the thyroid cartilage; the left common carotid extends from the highest point of the aortic arch, also to the upper edge of the thyroid cartilage; the left is therefore longer than the right. The relations of both, in the neck, are identical; the direction of each is oblique from before backward, and from within outward, along the external side of the trachea and larynx, in a line drawn from the sterno-clavicular articulation to a point midway between the mastoid process and the angle of the jaw. The sheath of each is derived from the deep cervical fascia, and contains also the internal jugular vein and the pneumogastric nerve, the artery being on the inner side, the vein on the outer side, and the nerve between them. At the root of the neck, the artery lies deeply, and it should not be ligatured at this point, unless absolutely necessary. It is covered, in this part, by the skin and platysma myoides, the superficial and deep fasciæ, the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles, in front; externally, it is in relation with the pneumogastric nerve and internal jugular vein; internally, with the trachea; behind, with the longus colli and rectus anticus major muscles, together with the transverse processes of the cervical vertebrae. On the right side, the internal jugular vein recedes from the artery; but, on the left, it approaches and often overlaps the artery. The carotid tubercle of Chassaignac, which is the anterior projection of the transverse process of the sixth cervical vertebra, is a precise guide to the artery when the neck is straight. It is from two to three inches above the clavicle (Holmes), and the artery lies in front and a little to the inner side of it.

At the root of the neck the operation may be done in the following manner (Fig. 476):—

¹ Mr. Abernethy, however, in 1798, had tied the primitive carotid, in the case of a man gored in the neck by a cow, the primary branches of the external carotid being torn off, and the internal carotid opened. Finding that he could stop the bleeding by compressing the common trunk between his thumb and a finger within the wound, he placed a ligature around the vessel. The bleeding was suppressed, but the patient died about thirty hours after the operation (Surg. Observations, vol. ii. p. 72, Am. ed.). Mr. Fleming, in 1803, successfully ligatured the primitive carotid for hemorrhage from a self-inflicted wound of the neck (Medico-Chirurgical Journal, vol. iii. p. 50). But, to Sir Astley Cooper the credit is unquestionably due of having first planned and executed this operation, in 1805, for the relief of aneurism.

(1) Place the patient on his back, with his head extended and inclined to the opposite side.

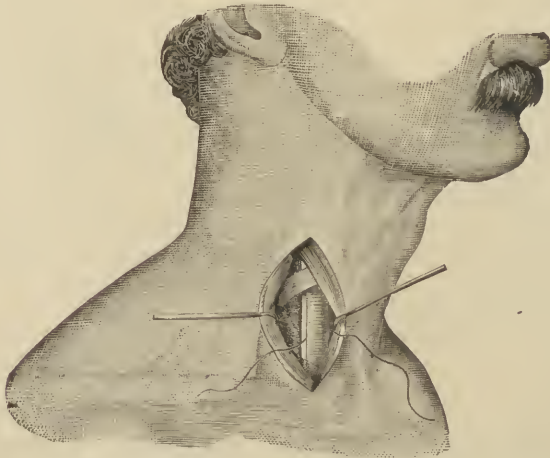
Fig. 475.



Surgical anatomy of the neck. (Sédillot.)

(2) Make a cutaneous incision, two and a half inches in length, between the two heads of the sterno-cleido-mastoid muscle downward to the clavicle,

Fig. 476.



Ligation of the right common carotid artery between the two heads of the sterno-cleido-mastoid muscle. (Sédillot.)

and ending seven-eighths of an inch to the outer side of the sterno-clavicular articulation.

(3) Divide the platysma and deep fascia; widen the interspace between the sternal and clavicular portions of the sterno-cleido-mastoid muscle with the fingers, until the internal jugular vein is visible.

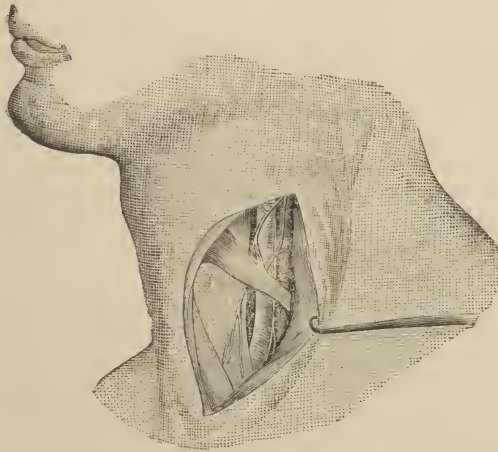
(4) By means of retractors, draw the vein with the clavicular portion of the sterno-cleido-mastoid carefully outward, and the sternal portion, together with the sterno-hyoid and sterno-thyroid muscles, inward; the pneumogastric nerve appears to the inner side of the vein, and the artery lies somewhat further inward and still deeper; the omo-hyoid muscle is seen crossing the vessels at the upper part of the wound.

(5) Open the arterial sheath, and pass the needle from without inward, carefully avoiding the internal jugular vein and the pneumogastric nerve by keeping the point of the needle close to the artery; compressing the vein with a finger at the upper part of the wound will cause it to collapse.

Just below the omo-hyoid muscle the common carotid is much more accessible, and at this point it is not unfrequently ligatured. It is here covered by the skin, the platysma myoides, the superficial and deep fasciæ, the sternal part of the sterno-cleido-mastoid, the sterno-hyoid, and sterno-thyroid muscles; it is obliquely crossed, from within outward, by the sterno-mastoid artery, likewise by the superior and middle thyroid veins, and, lower down, by the anterior jugular; on its external side are the pneumogastric nerve and the internal jugular vein; and on the inner side are the inferior thyroid artery and recurrent laryngeal nerve, which separate it from the trachea and thyroid gland; the descendens noni nerve lies on the sheath of the artery. (Fig. 475.)

To tie the common carotid below the omo-hyoid muscle, proceed thus (Fig. 477):—Place the patient on his back, with his head extended; make an

Fig. 477.



Ligation of the left common carotid artery below the omo-hyoid muscle. (Sédillot.)

Incision three inches in length along the inner border of the sterno-mastoid muscle, in the line above described, commencing on a level with the cricoid cartilage, and successively dividing the skin, superficial fascia, platysma myoides, and deep fascia, so as to expose the inner border of the sterno-mastoid muscle; carefully avoid the sterno-mastoid artery and the middle thyroid vein; bend the head forward, draw the sterno-mastoid muscle outward, and the sterno-hyoid and sterno-thyroid muscles inward, by retractors;

expose the anterior belly of the omo-hyoid muscle, and draw it upward; divide the deep fascia, and expose the sheath of the vessels; open it directly over the artery, carefully avoiding the descendens noni nerve, which runs along its tracheal side; press the pneumogastric nerve and the internal jugular vein away from the artery, that is, outward, and pass the needle from without inward, being careful not to include within the ligature the inferior thyroid artery and recurrent laryngeal nerve, which lie behind and on the inner side of the vessel. If the omo-hyoid muscle interfere with the operation, it may be turned aside, or even divided.

Above the omo-hyoid muscle the common carotid artery is still more accessible, and at this point it is very often ligatured. It is covered only by the skin, superficial fascia, platysma myoides, deep fascia, and anterior border of the sterno-mastoid; it is in relation internally with the larynx and pharynx, and, externally, with the pneumogastric nerve and internal jugular vein.

To tie the common carotid above the omo-hyoid, proceed thus:—Place the patient on his back, with his shoulders raised by a pillow, and his head turned to the opposite side; make an incision, three inches in length, commencing a little below the angle of the jaw, in the line above described, along the anterior border of the sterno-mastoid, dividing the skin, superficial fascia, and platysma myoides; then carefully raise the deep fascia on a grooved director, and incise it; avoid injuring the small underlying veins; flex the head to relax the muscles, and draw the margins of the wound apart with retractors; avoid the descendens noni nerve and the superior thyroid artery; open the sheath directly over the carotid; if the internal jugular vein swell up into the incision, compress it in the upper and lower parts of the wound, and draw it outward; pass the ligature from without inward, the point of the needle being kept close to the artery, in order to avoid wounding the internal jugular vein or including the pneumogastric nerve.

The point of election for deligating the common carotid artery is opposite to, or on a level with, the crico-thyroid membrane, and, in performing this operation, the omo-hyoid muscle is often drawn downward; otherwise the steps are identical with those just given.

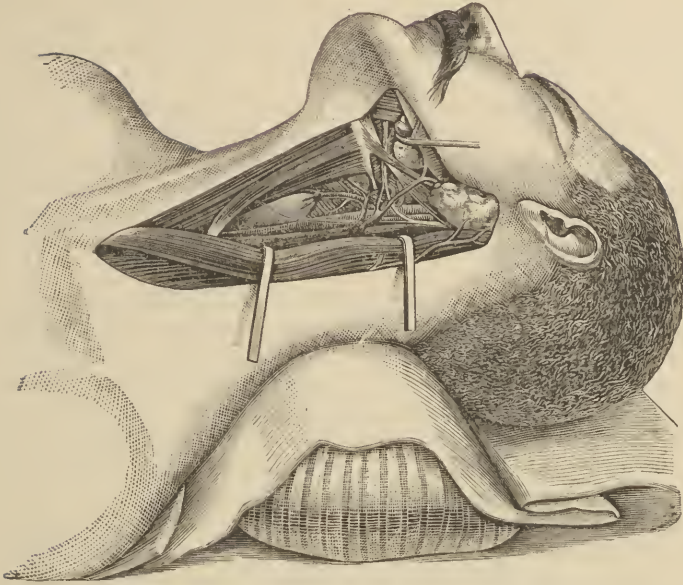
LIGATION OF THE EXTERNAL AND INTERNAL CAROTID ARTERIES.—These vessels arise from the common carotid by its bifurcation at the upper edge of the thyroid cartilage, and at their origin the external carotid is more superficial and internal than the other.

External Carotid.—The external carotid artery ascends almost perpendicularly from its origin to the deep sulcus behind the angle of the lower jaw, occupied by the parotid gland, underneath or through which it passes up to a point between the neck of the lower jaw and the meatus auditorius, where it divides into the temporal and internal maxillary arteries (Fig. 478).

Relations.—In front, the external carotid is crossed by the posterior belly of the digastric, stylo-hyoid, and platysma myoid muscles; by the hypoglossal nerve, near its origin; higher up it is situated in the substance of the parotid gland, and is crossed by the facial nerve. Behind, it is separated from the internal carotid by the stylo-pharyngeus and stylo-glossus muscles, the glosso-pharyngeal nerve, and a portion of the parotid gland.

Operation.—Place the patient in the position directed for ligating the common carotid. Make an incision from a point midway between the angle of the jaw and the anterior border of the sterno-mastoid muscle, parallel to and three-eighths of an inch in front of the latter, to a point half an inch below the upper border of the thyroid cartilage. The skin, superficial fascia,

Fig. 478.



Showing the surgical anatomy of the anterior superior cervical triangle.

platysma, and deep fascia, having been carefully divided, the last three laminae on a grooved director, the operator encounters the facial and lingual veins, and not unfrequently one or two lymphatic ganglia. If these veins cannot be readily drawn aside, each of them is to be tied with two ligatures, and divided midway between these. The external carotid artery may now be found, crossed by the hypoglossal nerve, and by the stylo-hyoid and posterior belly of the digastric muscle. It should next be cautiously separated, by means of a director, from the internal carotid artery and internal jugular vein, both of which run closely along its outer side. Pass the needle from without inward between the two carotids, carefully avoiding the internal jugular vein and the hypoglossal nerve. The operation of tying the external carotid artery has proved to be a very successful procedure, for of nineteen cases collected by Professor Agnew, "only one proved fatal from hemorrhage, and none from causes which could properly be attributed to the operation."¹ The terminal branches of the external carotid arteries freely anastomose together across the median plane. When, therefore, the external carotid has been tied for hemorrhage from a wound of its branches, should the hemorrhage return, it is proper to tie the other external carotid. This procedure has, thus far, been uniformly successful.²

Internal Carotid.—The *internal carotid artery* curves slightly outward from its origin, and then ascends nearly perpendicularly through the maxillo-pharyngeal space to the carotid foramen in the petrous bone. Its cervical portion is in relation, in front, with the stylo-glossus and stylo-pharyngeus muscles, the glosso-pharyngeal nerve and the parotid gland; externally, with the internal jugular vein, the glosso-pharyngeal, pneumogastric, and hypoglossal nerves; internally, it is in relation with the side of the pharynx,

¹ Principles and Practice of Surgery, vol. i. p. 636.

² American Journal of the Medical Sciences, October, 1873.

the tonsil, and the ascending pharyngeal artery; and, posteriorly, with the rectus anticus major, the sympathetic nerve, the pharyngeal and laryngeal nerves, which cross behind it, and, near the carotid foramen, with the glossopharyngeal, pneumogastric, and lingual nerves, and partially with the internal jugular vein.

Operation.—The internal carotid artery may be ligatured through the incisions just directed for tying the external carotid; the latter vessel being drawn forward, and the internal jugular vein being drawn backward, the point of the needle is cautiously insinuated underneath the artery from without inward, its movements being directed by the index finger of the free hand, and extreme care being taken that no structure besides the artery is embraced within the ligature.

Or, make an incision along the inner edge of the sterno-mastoid, three inches in length, from the angle of the jaw to the cricoid cartilage, through the skin, platysma, superficial and deep fasciæ; the inner border of the sterno-mastoid muscle now appears; cautiously separate the connective tissue, draw the sides of the wound apart, and the artery is exposed; draw the digastric muscle and hypoglossal nerve upward, and the internal jugular vein outward; the external and internal carotid arteries may now be ligatured both together, or either of them separately (Fig. 478).

In 1851, Keith, of Aberdeen, Scotland, tied the internal carotid artery with one ligature, on Hunter's plan.

In July, 1869, Dr. A. T. Lee, of Kingston, Tenn., successfully secured the internal carotid artery by two ligatures, one being applied on each side of an aperture in its walls made by a stab-wound of the neck. This case has already been mentioned in the section on punctured wounds of arteries.

In February, 1871, Dr. W. T. Briggs, of Nashville, Tenn., tied the internal carotid above and below with success.¹

In 1874,² a case was recorded by Dr. H. B. Sands, of New York, in which he successfully ligatured the internal carotid artery above and below the bleeding point, for secondary hemorrhage occurring ten days after an operation for the removal of the lower jaw, performed in October, 1872.

LIGATION OF THE SUPERIOR THYROID ARTERY.—This vessel is the first branch of the external carotid, and issues from it one-fourth of an inch below the great cornu of the hyoid bone. It curves downward and inward to the thyroid gland, in a tortuous course. At first, it is superficial, lying in the triangle formed by the sterno-mastoid, digastric, and omo-hyoid muscles. Before entering the thyroid gland, it divides into several branches which pass beneath the omo-hyoid, sterno-hyoid, and sterno-thyroid muscles.

Operation.—Place the patient's head in an extended position. Make an incision two inches in length along the inner border of the sterno-mastoid, the centre of which corresponds to the great cornu of the thyroid cartilage. Having divided the skin, superficial fascia, platysma myoides, and deep fascia, draw the sterno-mastoid outward and expose the omo-hyoid muscle, the internal jugular vein, and the common carotid artery. Then search with the director, or with the handle of a scalpel, for the superior thyroid artery, in the deep sulcus between the upper end of the larynx and the great vessels of the neck, where it is easily found and readily ligated. The needle should be passed from above downward.

LIGATION OF THE LINGUAL ARTERY.—*Surgical Anatomy.*—This artery is the second branch which issues from the front of the external carotid. It

¹ American Journal of the Medical Sciences, January, 1879, pp. 142, 143.

² New York Medical Journal, January, 1874.

arises about one-fourth of an inch above the superior thyroid, almost facing the great cornu of the hyoid bone. It ascends obliquely above the level of the latter, then curves abruptly downward and inward, and, passing underneath the outer margin of the hyoglossus muscle, runs parallel with and near to the great cornu of the os hyoides; finally, ascending to the under surface of the tongue, it runs forward in a serpentine course to the tip, under the name of the *ranine artery*, and terminates by inosculating with its fellow of the opposite side.

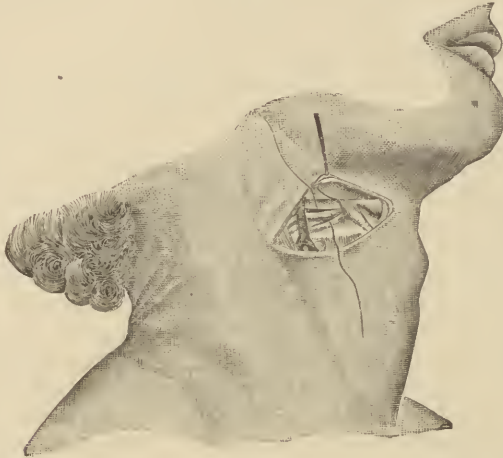
The hyoglossus muscle, underneath which the lingual artery passes, separates it into three portions or surgical divisions, the first being posterior to that muscle, the second beneath it, and the third anterior to it—that is, extending from the anterior margin of the hyoglossus to the tip of the tongue. All its branches, the hyoid, the dorsalis linguæ, and the sublingual, are given off in the second part of its course. The second part or division of the artery, that is, the portion under the hyoglossus muscle, is the part which has uniformly been chosen for deligation.

It is covered by the skin, superficial fascia, platysma myoides, deep fascia, the inferior border of the submaxillary gland, a second fold of the deep fascia which extends beneath the gland and completes its capsule, the facial, superficial lingual, and pharyngeal veins, the stylo-hyoid and digastric muscles, the hypoglossal nerve, and the hyoglossus muscle. It rests upon the middle constrictor of the pharynx, and runs along about one line above and parallel to the great cornu of the hyoid bone. To expose this portion (that is, the second) of the lingual artery, there are three important guides, namely, the glistening pulley of the digastric tendon, the great cornu of the os hyoides, and the hypoglossal nerve; the first two lie immediately below and in front of the artery, the last, immediately above and in front of it, and all three are separated from it by the hyoglossus muscle.

Operation.—Place the patient on his back, with his head turned a little to the opposite side and well extended, so as to amplify the space between the hyoid bone and the base of the jaw. Ascertain the position of the great cornu of the os hyoides; then begin the tegumentary incision at the anterior border of the sterno-mastoid muscle, half an inch above a point opposite to the extremity of the great cornu of the hyoid, and, continuing it forward and somewhat downward so as to give it a slight curve with the convexity below, terminate it three-fourths of an inch short of the median line, and half an inch below the base of the jaw (Fig. 479). The head must be rigidly maintained in the same position throughout the operation. Any material change of position, especially flexion, will alter every detail of the procedure. The incisions should all be made in a forward direction, that is, away from the great bloodvessels of the neck, which lie near the posterior end of the wound. The skin, platysma myoides, and the connective and adipose tissue being divided, the first layer of the deep fascia, or the anterior part of the capsule of the submaxillary gland, will appear. Divide it on a grooved director, and the gland will be exposed. With a finger, or the handle of a scalpel, detach the gland from its deep connections, and draw it upward over the jaw with a blunt hook, taking great care that the facial artery and vein, which pass through its substance, are not injured. Divide the portion of the deep fascia constituting the posterior part of the capsule of the gland, and the white shining aponeurosis which loops the digastric tendon to the great cornu of the os hyoides will be exposed, and, likewise, the insertion of the stylo-hyoid muscle. Immediately below them the hypoglossal nerve, accompanied by the lingual vein, will appear, three lines above the cornu of the hyoid, and running across the hyoglossus muscle, forward and upward, toward the middle of the jaw. Detach the nerve somewhat from the hyoglossus muscle by

scratching through the connective tissue which surrounds it, and push it upward out of the way. Fix the os hyoides by inserting a tenaculum into the digastric aponeurosis, then carefully insinuate the point of a director underneath the posterior margin of the hyoglossus muscle, and gently push

Fig. 479.



Ligation of the lingual artery. (Sédillot.)

it along close to the upper border of the great cornu of the hyoid bone, so as to separate the hyoglossus from the middle constrictor of the pharynx which lies behind. Now divide the fibres of the hyoglossus muscle on the director, and the lingual artery accompanied by a vein will be brought into view. Pass the needle from above downward in order to avoid the hypoglossal nerve. Occasionally a few fibres of the stylo-hyoid muscle must also be divided. Some surgeons gradually uncover this artery from before backwards, by raising the fibres of the hyoglossus with a forceps, and incising them with a knife. But at every step of the operation, after opening the superficial fascia, the operator should shape his course by feeling for the great cornu of the os hyoides with a finger in the wound.

Esmarch's Operation.—(1) The cutaneous incision is 4 centimetres (about $1\frac{1}{2}$ inches) in length, along the upper border of the great cornu of the hyoid bone. (2) The platysma is divided; the posterior facial vein is drawn outward. (3) The posterior belly of the digastric muscle is exposed; behind and below it, appears the hypoglossal nerve; the submaxillary gland is drawn upward. (4) The hypoglossal nerve runs in front over the hyoglossus muscle, accompanied by the lingual vein; below the nerve and behind the hyoglossus muscle passes the lingual artery. (5) Between the hypoglossal nerve and the great cornu of the hyoid bone the fibres of the hyoglossus are cautiously divided; immediately beneath this muscle lies the lingual artery, accompanied by a vein.

Ligation of the lingual artery is one of the most difficult of all ligations; and, therefore, I have very attentively considered it. Esmarch lays down the steps with clearness and brevity. From the great freedom of inosculation, which exists between the two lingual arteries, it is often necessary to tie both of them to suppress hemorrhage from wounds of the tongue.

LIGATION OF THE FACIAL ARTERY.—*Surgical Anatomy.*—The facial artery is the third branch which issues from the front of the external carotid. It

arises a little above the great cornu of the os hyoides, and passes obliquely to the submaxillary gland, in which it lies embedded. It then curves over the body of the lower jaw, close to the anterior inferior angle of the masseter muscle, ascends to the angle of the mouth, and thence to the inner canthus of the eye, where it is named the angular artery. Over the buccinator muscle its course is tortuous to accommodate itself to the movements of the jaw.

Below the jaw, it passes under the digastric and stylo-hyoid muscles; on the body of the jaw it is covered by the skin, superficial fascia, and platysma myoides, and lies on the periosteum in a groove which is found at the junction of the posterior third with the anterior two-thirds of the body of the bone. The facial vein runs on its outer side. The groove just mentioned is the point usually selected for the deligation of the artery.

Operation.—Having recognized the pulsations of the artery, make an incision one inch in length, along its course over the body of the lower jaw, as just described (Fig. 480), through the skin, superficial fascia, and platysma

Fig. 480.



Ligation of the facial and temporal arteries. (Sédillot.)

myoides; separate the lips of the incision, and detach the connective tissue from the artery, which is thus exposed; draw the facial vein and masseter muscle outward, and pass the needle between the two vessels.

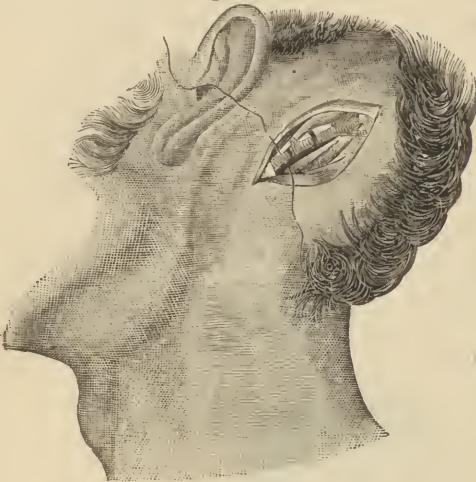
LIGATION OF THE TEMPORAL ARTERY.—This artery is the more superficial of the two terminal branches of the external carotid. It commences in the substance of the parotid gland, opposite the meatus auditorius externus, ascends almost longitudinally over the root of the zygoma, and, at one inch and a half or two inches above the zygomatic arch, divides into the anterior and posterior temporal branches.

Operation.—Having determined the position of the artery by its pulsations, make an incision through the skin, one inch in length, at a point above the zygoma and in front of the ear, then divide the dense connective tissue on a director, and the artery will be exposed. Pass the needle from behind forward, in order to avoid the temporal vein and the auriculo-temporal nerve (Fig. 480).

LIGATION OF THE OCCIPITAL ARTERY.—The occipital artery arises from the external carotid, opposite the facial, passes backward beneath the posterior belly of the digastric, stylo-hyoid, trachelo-mastoid, and sterno-mastoid

muscles, to the occipital groove in the mastoid portion of the temporal bone. It then ascends between the splenius and complexus muscles, and divides

Fig. 481.



Ligation of the occipital artery. (Sédillot.)

into two branches, which are distributed upon the occiput. The hypoglossal nerve curves around this artery near its origin, from behind forward.

Operation.—To tie the artery near its origin, make an incision along the inner border of the sterno-mastoid muscle, two inches in length, and at the angle formed by this muscle and the digastric. Having carefully divided the deep fascia, expose and isolate the artery, carefully protecting the hypoglossal nerve.

To tie the artery behind the mastoid process, make an incision two inches long, half an inch behind and a little beneath the mastoid process, obliquely upward and backward (Fig. 481). Divide the skin and aponeurosis of the sterno-mastoid muscle, likewise the splenius muscle, to the limits of the

wound. The pulsations of the artery are recognized by the finger. It should then be separated from the occipital vein and tied.

If the artery be denuded near the mastoid process, much care must be used not to damage the large mastoid tributaries which hereabout enter the occipital vein, and establish a communication between it and the lateral sinus of the dura mater.

LIGATION OF THE VERTEBRAL ARTERY.—*Surgical Anatomy.*—This vessel is the first and largest of the branches of the subclavian artery. It ascends through the foramina in the transverse processes of all the cervical vertebrae, excepting the last; then winds backward around the articulating process of the atlas; and, piercing the dura mater, enters the skull through the foramen magnum. The two vertebral arteries unite at the lower border of the pons Varolii to form the basilar artery. Each vertebral artery, with the vertebral vein, lies in front of the cervical nerves in the foramina of the transverse processes of the six upper cervical vertebrae. Before entering the so-called vertebral canal in the transverse processes just mentioned, the artery passes behind the internal jugular vein and the inferior thyroid artery, to the transverse process of the sixth cervical vertebra, ascending between the scalenus anticus and longus colli muscles, in a line drawn from the posterior part of the mastoid process to the junction of the inner fourth of the clavicle with the outer three-fourths of the same.

Operation.—Place the patient on his back, with his shoulders depressed and his face turned to the opposite side, and make incisions like those employed in Mott's operation for tying the innominate, that is, make one cut through the skin, superficial fascia, and platysma myoides, $2\frac{1}{2}$ or 3 inches in length, along the anterior border of the sterno-mastoid muscle, and terminating half an inch above the sternum, and another cut of the same depth and length above the clavicle, parallel therewith and half an inch therefrom, to meet the termination of the first cut. Carefully raise and divide the sternal root, together with the anterior part of the clavicular root, of the sterno-cleido-mastoid muscle. Reflect the angular flap, so as to bring into view the common sheath of the

primitive carotid artery, the internal jugular vein, and the pneumogastric nerve. Separate with a finger the cellular connection of the common sheath to the sterno-thyroid muscle, and finally to the longus colli. The head is now to be raised, though still turned to the opposite side, and the common sheath, etc., drawn outward, the sterno-thyroid muscle, etc., being drawn inward, by retractors; separate the connective tissue at the bottom of the wound, and expose the aponeurosis which passes from the scalenus anticus to the longus colli, and the anterior part of the transverse process of the sixth cervical vertebra, that is, "the carotid tubercle of Chassaignac." Then cautiously open the aponeurosis an inch below this point, and the artery is found lying very deep. Pass the needle from without inward. Take especial care to avoid injuring the phrenic and the sympathetic nerves; the "thyroid ganglion" of the latter, and its communicating branches being considerably exposed. Should difficulty be experienced in finding the artery, a finger must be inserted to the bottom of the wound, and search made with it for the "carotid tubercle of Chassaignac," at the extremity of the transverse process of the sixth cervical vertebra, below which the pulsations of the artery may be felt.

From the peculiarity of termination of the vertebral artery, above mentioned, the blood may flow backward, or regurgitate, in it, with almost the same freedom, as it flows forward, or toward the brain; wherefore, this artery, when wounded before it reaches the carotid tubercle, must always be ligatured at the injured part, and with a distal, as well as a proximal, thread, the exposure of the vessel being made by cautiously dilating the original wound.

But, in cases of subclavian aneurism, deligation of this artery in its continuity is not unfrequently necessary because of the great freedom, just mentioned, with which the blood regurgitates in it when the innominate is tied, or the subclavian on the cardiac side of its origin. Thus, Dr. Smyth, in the only successful case of ligation of the innominate, was compelled to tie the vertebral artery as well as the common carotid. Professor Willard Parker, of New York, has tied this artery simultaneously with the common carotid and the subclavian arteries, in a case of subclavian aneurism. Maisonneuve ligatured the vertebral and inferior thyroid arteries for hemorrhage from a shot-wound of the neck, and extracted the missile; the bleeding ceased, but death ensued from purulent infiltration of the spinal canal. Two additional cases in which this artery was ligated have been reported by an Italian surgeon.

Distal ligature of the vertebral artery between the atlas and the axis, as well as between the occipital bone and the atlas, as suggested by Dietrich, would be both difficult in performance and uncertain in result.

LIGATION OF THE INFERIOR THYROID ARTERY.—This vessel arises from the thyroid axis, and ascends obliquely, in a tortuous course, behind the common sheath of the primitive carotid artery, the internal jugular vein, and the pneumogastric nerve, to the inferior part of the thyroid gland, to which it is distributed. It is in relation with the middle cervical ganglion of the sympathetic, the "thyroid ganglion" of Haller, and the communicating branches thereof; they lie in front of it.

Operation.—Proceed as for ligation of the primitive carotid artery between the two heads of the sterno-cleido-mastoid muscle (Fig. 476), until the common sheath of the carotid, the internal jugular vein, and the pneumogastric nerve, are brought into view. Then draw the common sheath of these vessels, etc., outward, that is, away from the thyroid gland, and search, just below that body, with a finger in the deep fissure between the common sheath of the great vessels and the œsophagus, for the artery as it ascends behind the

common sheath, obliquely inward, where it should be tied. Pains should be taken to avoid injuring the middle cervical ganglion of the sympathetic, and its communicating branches. The needle should be passed from without inward.

Ligation of both inferior thyroid arteries has been performed a number of times for vascular enlargements of the thyroid gland, but the results have not been of such a character as to warrant a repetition.

However, for hemorrhages from wounds of the neck, as in Maisonneuve's case mentioned above, in which the vertebral was also tied, the operation must be resorted to whenever it appears expedient.

LIGATION OF THE INTERNAL MAMMARY ARTERY.—The internal mammary artery is the first branch which issues from the *lower* side of the subclavian artery. It runs directly downward behind the clavicle, on the posterior surface of the costal cartilages, and near the edge of the sternum, until it reaches the sixth intercostal space; there it divides into the musculo-phrenic and superior epigastric arteries. It is accompanied by two veins. The internal mammary artery is crossed in the first part of its course by the internal jugular and subclavian veins, and by the phrenic nerve; in the chest, it lies at first on the costal cartilages and intercostal muscles, and is covered by the pleura behind, but lower it is covered also by the triangularis sterni muscle. Ligation of the external mammary is esteemed easy of performance in the first three intercostal spaces, difficult in the fourth, very difficult in the fifth, and almost impossible in the sixth.

Goyrand's Operation.—An incision two inches in length is to be made near the edge of the sternum obliquely from above downward and from without inward, forming with the axis of the body an angle of forty-five degrees. The middle part of this incision should be three or four lines distant from the margin of the sternum, and in the centre of the sternal extremity of the intercostal space. Dividing successively the skin, the cellulo-adipose subcutaneous tissue, and the great pectoral muscle, the intercostal space is exposed. An incision is then to be made in the same direction and over the entire width of the space of the aponeurotic layer which continues the external intercostal muscle and the superficial fasciculi of the internal intercostal. With a grooved director the fibres of the latter muscle are to be separated and torn through, and the artery and its two venæ comites are then laid bare at three lines from the edge of the sternum, separating those fibres from the pleura. Then nothing is easier than to isolate the artery, and pass the needle beneath it.

Goyrand's operation is recommended by Guthrie, and I have no doubt that it constitutes the best method of ligating the internal mammary artery in its continuity.

When, however, traumatic hemorrhage occurs from this artery, it should always be secured at the place of injury by a distal ligature as well as by a proximal ligature; and when the arterial lesion is situated in the fourth, fifth, or sixth intercostal spaces, it will often be advisable to cut out one of the costal cartilages with bone-forceps, either wholly or in part, in order to obtain room for passing a distal and proximal ligature.

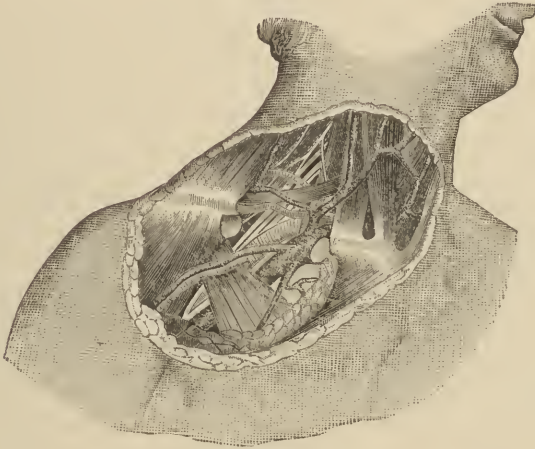
During the late civil war, the internal mammary artery was tied for secondary hemorrhage by Judson and by Bontecou, but in neither instance was the operation successful.

LIGATION OF THE SUBCLAVIAN ARTERY.—*Surgical Anatomy.*—On the right side, the subclavian artery issues from the innominate artery; on the left, from the arch of the aorta. The right is, therefore, shorter than the left,

and lies nearer to the anterior wall of the chest; it is also somewhat larger, that is, greater in circumference, because it is a branch of a branch, instead of being a direct offshoot from the main trunk.

The course of each subclavian artery is divisible, for surgical as well as for anatomical purposes, into three parts marked by the *scalenus anticus* muscle behind which the vessel passes, namely, the *first* part, extending from its origin to the inner margin of the *scalenus anticus*, the *second* part, lying directly behind the *scalenus anticus*, and the third part, extending from the outer border of the *scalenus anticus* to the inferior margin of the first rib. On the right side, the *first* part ascends obliquely outward to the inner border

Fig. 482.



Surgical relations of the subclavian artery and subclavian vein. (Sédillot.) A portion of the clavicle has been removed.

of the *scalenus anticus*; on the left side, it ascends longitudinally to the inner border of that muscle. On both sides, the *second* part curves outward behind the *scalenus anticus*. On both sides also, the *third* part passes downward and outward beneath the clavicle, to the inferior margin of the first rib, where it becomes the axillary artery.

Relations.—On the *right* side, the *first* part is in relation, in front, with the internal jugular and subclavian veins at their point of junction, and is crossed by the pneumogastric nerve, cardiac nerves, and phrenic nerve. Behind and beneath, it is invested by the pleura; it is also crossed by the right recurrent laryngeal nerve, and by the vertebral vein, and is in relation with the transverse process of the seventh cervical vertebra. On the *left* side, the *first* part is in relation in front with the pleura, the vena innominata, the pneumogastric and phrenic nerves (they run parallel to it), and the left carotid artery. To its inner side lies the œsophagus; to its outer side, the pleura; and, behind, the thoracic duct, longus colli, and vertebral column.

The *second* part, on both sides alike, lies between the two *scaleni* muscles, and is supported by the first rib. The *scalenus anticus* separates the artery from the subclavian vein and the phrenic nerve. Behind, it is in relation with the brachial plexus of nerves.

The *third* part, on both sides alike also, is in relation, in front, with the subclavian vein and subclavian muscle; behind, with the brachial plexus of nerves and *scalenus posticus* muscle; above, with the supra-scapular artery and *trapezius* myoides; and below, with the first rib.

Operation at the First Part.—To tie the *right* subclavian on the tracheal side of the scaleni, place the patient on his back, with his shoulders raised and his head turned to the opposite side. Make two incisions, one parallel to the inner portion of the clavicle, and the other along the inner border of the sterno-cleido-mastoid muscle, each three inches in length, and joining at an acute angle. Pass a director behind the sternal attachment of the sterno-cleido-mastoid, and divide it as well as the connective tissue; avoid small arteries and veins in this place, especially the anterior jugular vein. Divide, likewise, the sterno-hyoid and sterno-thyroid muscles on a director. Open the deep cervical fascia by scratching it with a finger nail or end of the director, and expose the internal jugular vein, which being pressed aside (inward), pass the needle around the artery from below upward to avoid the pleura. To tie the *left* subclavian on the tracheal side of the scaleni, place the patient in a position corresponding to that above described. Make an incision three and one-half inches long, through the skin and platysma myoides, on the inner edge of the sterno-cleido-mastoid muscle, terminating at the sternum; this is to be met by another incision along the sternal part of the clavicle, two and one-half inches in length. Divide the sternal and half of the clavicular origin of the sterno-cleido-mastoid muscle on a director, and raise the angular flap. Penetrate the deep fascia with the handle of the scalpel and the fingers. Continue the dissection along the outer side of the internal jugular vein to the inner edge of the scalenus anticus muscle, half an inch above the first rib, to avoid the thoracic duct. The phrenic nerve must be recognized and avoided; and the fingers pressed to the bottom of the wound will discover the rib, and then the artery. Pass the needle from below upward. (J. Kearney Rodgers.)

Operation at the Second Part.—The portion of the artery embraced between the scaleni muscles is very short. It is covered by the skin, the platysma myoides, the sterno-cleido-mastoid muscle, and the scalenus anticus, upon which rests the phrenic nerve; below, lies the pleura; and above, the brachial plexus of nerves. Lay bare the deep cervical fascia by an incision three and one-half inches in length, parallel to and half an inch above the clavicle, commencing at the inner edge of the trapezius muscle. Penetrate this fascia by tearing it with the handle of the scalpel and with the fingers. Divide the outer part of the clavicular origin of the sterno-cleido-mastoid muscle. Find the tubercle of the first rib, and the insertion into it of the scalenus anticus. Bring into view the phrenic nerve as it passes over this muscle, in order to avoid it. Begin at the outer edge of the muscle, some distance from the rib, and cautiously divide its fibres from before backward, and from without inward; the retraction of the severed fibres will expose the artery. The portion of the muscle upon which rests the phrenic nerve must not be disturbed. If the muscle be incised too near the rib, the internal mammary artery may be wounded. Pass the needle from without inward.

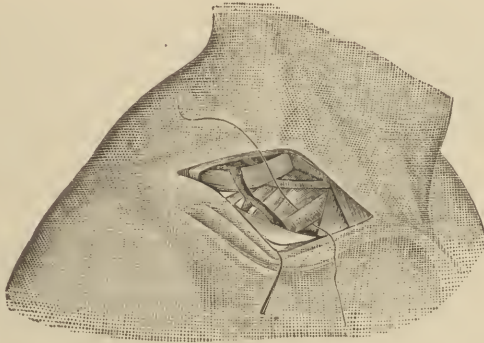
Operation at the Third Part, or the Point of Election.—To tie the subclavian artery external to the scaleni muscles, place the patient on his back with the shoulders moderately raised, the head extended, the face turned somewhat to the opposite side, and the arm drawn downward. Make an incision through the skin, two and one-half or three inches in length, about half an inch above and parallel to the clavicle, from the anterior border of the trapezius to the posterior border of the sterno-cleido-mastoid muscle. Divide the platysma, with the superficial fascia, and the border of the sterno-cleido-mastoid muscle will be exposed; the external jugular vein must not be injured. With the fingers and the handle of the scalpel divide the connective and adipose tissue. The omo-hyoid muscle and supra-scapular artery are to be drawn upward. Continue the dissection, by means of the fingers and the handle of the scalpel only, through the adipose and connective tissue with its veins, to the scalenus

antecus muscle, the outer edge of which can be distinctly felt extending upward from the tubercle of the first rib; behind and just external to the outer edge of this muscle, the pulsations of the artery can be felt. The inner border of the brachial plexus of nerves now appears, and is to be drawn upward and outward. Between the scalenus anticus and the brachial plexus, but somewhat deeper than the latter, lies the artery. Divide the deep layer of the cervical fascia with the fingers and the handle of the scalpel, or the point of the director, and the artery then comes into view. The subclavian vein lies in front of and below the tendon of the scalenus anticus, and close to the clavicle. Open the sheath of the artery by tearing it with the finger nail, and gently insinuate the point of the needle, from before backward and slightly from within outward, keeping it close to the artery. Also guide the point of the needle by the end of the finger, and prevent it, when emerging on the opposite side, from including a branch of the brachial plexus. Injury of the external jugular vein (at the outer border of the sterno-cleido-mastoid), of the supra-scapular artery (above the clavicle), and of the phrenic nerve (running downward upon the scalenus anticus), must be avoided.

Sometimes the clavicular portion of the sterno-cleido-mastoid muscle has an unusually broad attachment to the clavicle, as has also the trapezius, in which case the clavicular attachment of the former must likewise be divided until sufficient room is obtained. Sometimes, too, the external jugular vein enters the supra-clavicular fossa at such a point that it cannot be drawn into either angle of the incision, in which case it must be tied with two ligatures and divided between them.

The cutaneous incision directed above is substantially that recommended by Hodgson (Fig. 483). Roux, however, advised a longitudinal incision, the

Fig. 483.



Hodgson's operation for tying the subclavian artery external to the scalenus anticus. (Sédillot.)

lower end of which should rest on the clavicle; Marjolin advocated an incision shaped like an inverted **L**; and Physick preferred one fashioned like the letter **V**. But, as Sédillot justly observes, the procedure of Hodgson is the simplest and the best, and ought to be generally adopted. It has been sanctioned by Lisfranc, Sanson, Velpeau, Sédillot, etc., in France, and, I believe, is generally preferred by the surgeons of Great Britain and America. I also know from experience that the artery can be exposed with great facility by this method.

But the ease and celerity with which the operation is performed will very much depend upon keeping the surface of the dissection unstained with blood, which can be done, as I likewise know from experience, by not using the cutting edge of the knife at all, in ordinary cases, after dividing the

platysma myoides, the dissection being prosecuted with the fingers, etc., in the manner above described, and the landmarks of the operation being constantly kept in view or felt for: these are the omo-hyoid muscle and the brachial plexus of nerves, above; the first rib, below; the tense, sharp, outer edge of the scalenus anticus, together with the tubercle of the first rib, internally; and the pulsations of the artery itself just behind and external to the outer edge of the scalenus anticus muscle.

The operation of ligating the subclavian artery on the *outer side of the scaleni muscles* was attempted, for the first time, in 1809, by Sir Astley Cooper. In the same year a ligature was passed around the artery for axillary aneurism, by Ramsden, at St. Bartholomew's Hospital, and the patient survived five days. Between that date and 1816, the operation was repeated by Sir William Blizard, by Thomas Blizard, and by Dr. Colles, but all three of the patients died. The first successful deligation of the subclavian artery was performed, in 1817, by Dr. Wright Post, of New York; and in 1820, Liston obtained an equally happy result from the same operation.

The operation of tying the subclavian on the *tracheal side of the scaleni* was performed, for the first time, in 1818, by Dr. Colles, and with a fatal result. Including Banks's case, it has been practised twenty times, death following in every instance. Five of these operations have been performed in America: by J. Kearney Rodgers, in 1845; by Valentine Mott, in 1851; by Willard Parker, in 1863; and by S. C. Ayres and C. H. Bullen, in 1864. The two last-mentioned cases occurred during the late civil war.

The operation of ligating the subclavian artery *between the scaleni muscles*, that is, in the second part of its course, was likewise twice performed during the late civil war, namely, by Surg. J. H. Grove, U. S. Vols., at Rome, Ga., in 1864; and by Surg. B. B. Breed, U. S. Vols., at Nashville, Tenn., in 1865. Both operations were unsuccessful.¹

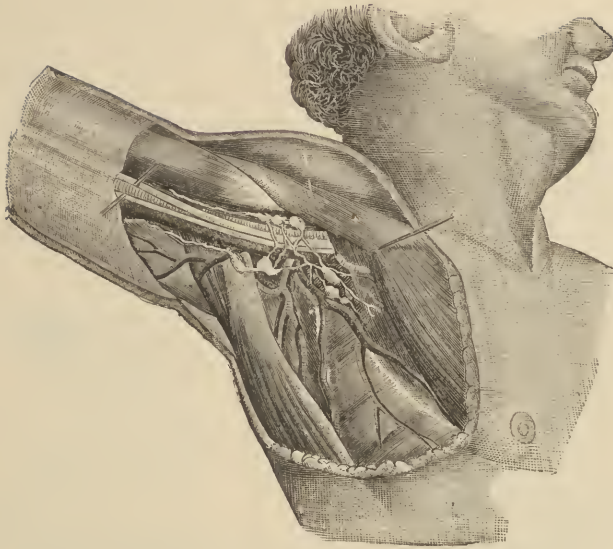
LIGATION OF THE AXILLARY ARTERY.—*Surgical Anatomy.*—The axillary artery gently curves outward and somewhat downward, through the middle of the axillary space, from the inferior margin of the first rib to the inferior border of the latissimus dorsi muscle, where it becomes the brachial artery. (Figs. 482, 484.) It is crossed by the pectoralis minor muscle, which divides its course into three unequal parts, namely: (1) the part internal to or above the pectoralis minor; (2) the part behind or covered by that muscle; and (3) the part external to or below it (Fig. 482).

Relations.—Having emerged underneath the costo-coracoid membrane, the artery is in immediate relation with the axillary vein, which lies at first to the inner side, and then in front of it. Near the middle of the axilla, the artery is embraced by the two heads of the median nerve, and is crossed in front by the pectoralis minor muscle. Internally, that is, on the thoracic side, it is in relation above with the first intercostal muscle; it next rests upon the first serration of the serratus magnus; and below, it is separated from the chest by the brachial plexus of nerves. Externally, that is, on the humeral side, it is separated at first from the brachial plexus by a triangular cellular interval; it next rests against the tendon of the subscapularis muscle; and, finally, is in contact with the coraco-brachialis muscle. Seven important branches issue from it.

Hogdson's Operation. (Fig. 485.)—The patient having been placed on his back, the operator makes a semilunar incision through the integuments, just below the clavicle, three or four inches in length, commencing about

¹ Medical and Surgical History, etc., First Surgical Volume, pp. 546, 547.

Fig. 484.

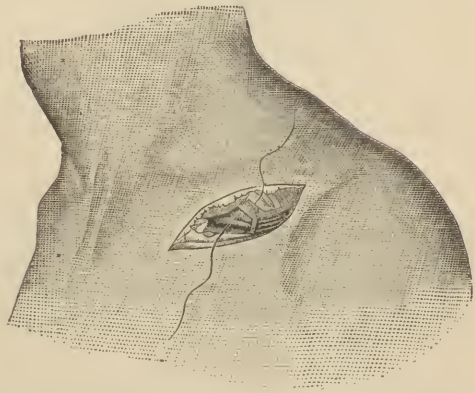


Surgical anatomy of the axillary region (Sédillot.)

an inch from the sternal end of the clavicle, and terminating near the anterior margin of the deltoid muscle's attachment to that bone, taking care not to cut the cephalic vein. The fibres of the pectoralis major are to be divided in the same direction and to the same extent. The semilunar flap thus formed is then raised, when the pectoralis minor will be seen crossing the inferior part of the wound. The pulsations of the artery can be distinctly felt between the superior margin of this muscle and the clavicle. The axillary vein lies below the artery, but if swollen it may overlap it. One trunk of the brachial plexus of nerves lies above, and in contact with the artery, but the other trunks thereof run behind it. The artery is isolated by scratching with the finger nail, and passing the needle under it from before backward, and slightly from within outward, avoiding the vein. The point of the needle is guided with the point of the index finger, as it emerges, and is thus kept from taking up any branch of the brachial plexus of nerves.

Chamberlaine's Operation.—Make a transverse incision, three inches in length, through the skin and platysma, along and upon the lower edge of the clavicle, commencing three fingers' breadth from the sternal end of that bone, and ending about an inch from the acromion process of the scapula. Make a second incision, three inches in length, obliquely through the integuments, over the deltoid and pectoral muscles, meeting the first nearly in the centre. Remove the cellular membrane and fat. Detach the clavicular portion of the

Fig. 485.



Hodgson's operation for tying the axillary artery immediately under the clavicle. (Sédillot.)

pectoralis major, and remove the cellular tissue overlying the axillary vessels. The artery is now brought into view, and its pulsations make it clearly distinguishable from the contiguous parts. The pectoralis minor and the margin of the deltoid are also brought into view (Fig. 486). Separate the artery from the axillary vein lying in front, and from the brachial plexus of nerves behind. Cautiously pass a ligature with the improved American or with Mott's artery needle, keeping the point of the instrument close to the artery so as not to embrace any other part. The cephalic vein must not be injured by the incisions.

Fig. 486.



Chamberlaine's operation for tying the axillary artery.
(Sédillot.)

Fig. 487.



Delpech's operation for tying the axillary artery.
(Sédillot.)

Delpech's Operation.—Make a slightly oblique incision downward from the junction of the outer third with the inner third of the clavicle, along the interstice between the pectoralis major and deltoid muscles (Fig. 487). Strongly separate or retract these muscles, and divide the pectoralis minor on a grooved director. Then introduce the left index finger to the bottom of the wound, and, bending it like a hook under the mass of vessels and nerves, draw them outward. Tie the artery at the point where it is embraced between the two heads of the median nerve, carefully avoiding the axillary vein, which lies below and internally, and the trunks of the brachial plexus of nerves, which are found above and external to it.

This procedure has the serious fault of requiring the nerves and vessels to be pulled or dragged with more or less of violence, and to be isolated by lacerating the cellular tissue which surrounds them. The operations of Hodgson and Chamberlaine are therefore to be preferred. In performing each of these three operations, especially the last, care must be taken that the cephalic vein be not wounded.

Operation in the Axillary Hollow or Armpit.—Below the pectoralis minor, that is, in the third part of its course, the artery is quite superficial, being covered only by the integuments and deep fascia. Place the patient on his back, with the arm extended and rotated outward (Fig. 488). The operator should stand on the outer side, if it be the right arm, and on the inner side if it be the left arm. Having found the inner border of the coraco-brachialis muscle, and the place where the artery pulsates, make an incision two or three inches

in length, along the line indicated in the accompanying wood-cut (Fig. 488), dividing the skin only. Incise the fascia on a director. Then the axillary vein is to be pushed backward with the end of the director, and next the brachial plexus of nerves. The median nerve is now recognized, and, being drawn forward, while the internal cutaneous and ulnar nerves are pushed backward, the artery is exposed. Cautiously separate the artery from the vein, which is pushed backward, and the nerves that surround it. Pass the needle from behind forward.

The axillary artery was ligatured, for the first time, on January 17, 1815, by Mr. R. Chamberlaine, of Kingston, Jamaica, for an aneurism of the left axilla, occasioned by a wound with a cutlass, received October 5, 1814. The operation proved successful.

LIGATION OF THE BRACHIAL ARTERY.—The brachial artery passes down the inner side of the arm, from the lower border of the latissimus dorsi to a point about an inch below the bend at the elbow, where it divides into the radial and ulnar arteries. Its course is indicated by a line drawn from the junction of the anterior and middle thirds of the axilla to the middle of the bend at the elbow.

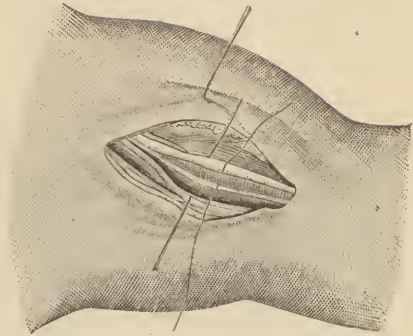
Operation in the Upper Third of the Arm.—Having placed the patient on his back, with the arm extended and rotated outward, make an incision, two inches in length, along the inner border of the coraco-brachialis. The artery is readily exposed. It lies between and behind the median and ulnar nerves, the former to the outer and the latter to the inner side. It has two venæ comites.

Operation in the Middle Third.—The brachial artery in the middle of the arm descends on the inner side, first of the coraco-brachialis, and afterward of the biceps. It is covered by the integuments and fascia, and is slightly overlapped by the biceps. The internal cutaneous nerve lies superficial to the artery. The median nerve obliquely crosses it. The ulnar nerve is internal to it.

The arm being extended at right angles to the trunk, and held supine, the course of the artery may be ascertained by its pulsations; by the internal margin of the biceps and coraco-brachialis; by the median nerve; and by the line above described. The steps of the operation are as follows: (1) The *cutaneous incision* is 4 centimetres (about $1\frac{1}{2}$ inches) in length along the inner border of the biceps. (2) The *biceps* is drawn outward with a retractor. The median nerve is seen lying immediately upon the artery. (3) The *median nerve* is detached from the sheath and drawn outward by a strabismus hook (Fig. 489): the *sheath of the artery* is then opened; it lies between two veins (venæ comites). The arm is now flexed, the artery isolated, and the ligature passed from without inward. Sometimes the brachial artery divides into the ulnar and radial arteries in the upper third of the arm; the radial, in that case, commonly runs more superficially and externally (upon the biceps), while the ulnar appears conspicuously small (Esmarch).

Operation at the Elbow.—The brachial artery, at the elbow, lies in the centre of a triangular space, formed externally by the supinator longus, and internally by the pronator radii teres. (1) The *cutaneous incision* is made 4

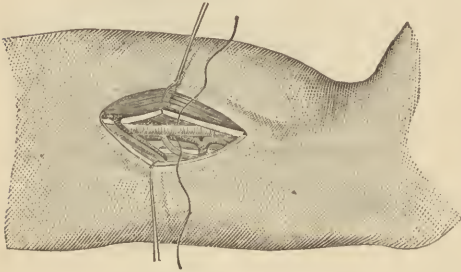
Fig. 488.



Ligation of the axillary artery, in the armpit.
(Sédillot.)

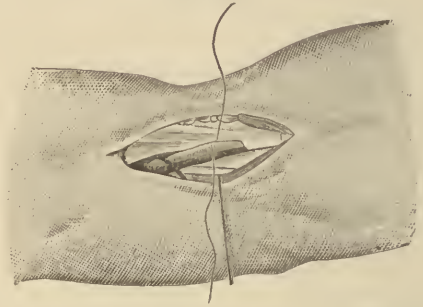
centimetres (about $1\frac{1}{2}$ inches) in length, and 5 millimetres (a fifth of an inch) to the inner side of the tendon of the biceps; carefully, so as not to injure the median vein, which is drawn downward (Fig. 490). The bicipital fascia

Fig. 489.



Ligation of the brachial artery in the middle of the arm. (Sédillot.)

Fig. 490.



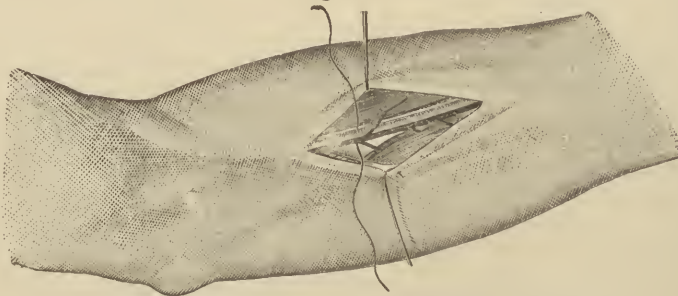
Ligation of the brachial artery at the elbow. (Sédillot.)

is divided. Immediately beneath it is the artery, lying on the brachialis anticus muscle, and between the venæ comites. The median nerve lies a few millimetres inward, and passes beneath the pronator radii teres (Esmarch).

LIGATION OF THE RADIAL ARTERY.—Although the radial artery is smaller than the ulnar, it directly continues the course of the brachial artery, and runs in a line drawn from the middle of the bend at the elbow to the inner side of the styloid process of the radius. It is superficial in nearly all its course. The radial nerve lies on its outer or radial side. It has two venæ comites.

Operation in the Upper Third.—Having extended the arm in a supine position, and having raised the superficial veins by compressing them above, make an incision through the skin and superficial fascia, two inches in length, along the inner margin of the supinator longus, if this is recognized, or in the line just indicated. Raise the deep fascia on a grooved director, and divide it. Flex the forearm somewhat, to relax the muscles; then, drawing the supinator longus aside, the sheath of the artery is exposed. Pass the needle from without inward (Fig. 491).

Fig. 491.

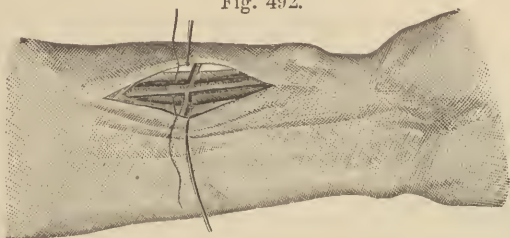


Ligation of the radial artery in its upper third. (Sédillot.)

Operation in the Lower Third.—Here the artery lies very superficial, between the tendons of the supinator longus and flexor carpi radialis, and its pulsations are very distinct. The forearm being supine and the hand forcibly extended, to show the flexor tendon, make a light incision, two inches in length, on the radial side of the flexor carpi radialis tendon. Cautiously

raise the deep fascia on a director, and divide it. This brings into view the artery with its *venae comites*, and the radial nerve lying on its outer or radial side (Fig. 492). The needle may be passed in either direction.

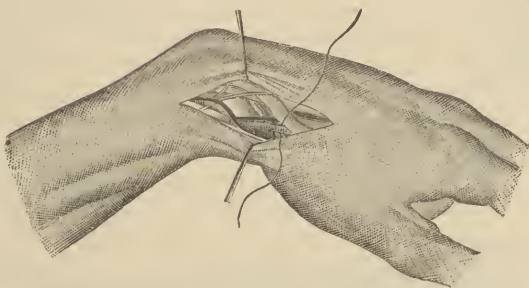
Fig. 492.



Ligation of the radial artery in its lower third. (Sédillot.)

Operation on the Dorsum of the Wrist.—Below the styloid process of the radius, the artery runs in the groove between the upper extremities of the first metacarpal bones, and a fibrous band separates it from the tendons of the thumb (Fig. 493). It may be ligatured just before it forms the deep

Fig. 493.



Ligation of the radial artery on the dorsum of the wrist. (Sédillot.)

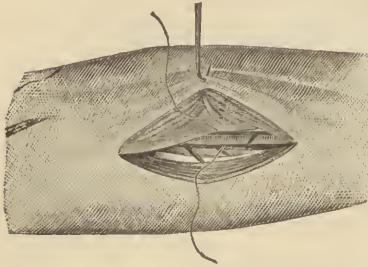
palmar arch; or a little below and behind the extremity of the styloid process of the radius, as it passes under the extensor muscles of the thumb, between the extensor *primi internodii* and the extensor *secundi internodii pollicis*. To tie the artery at the commencement of the *deep palmar arch*, make an incision, one inch in length, along the ulnar border of the extensor *secundi internodii pollicis*, at the angle formed by the first two metacarpal bones, taking care not to wound the superficial veins, and the artery is readily exposed. To tie the artery below and behind the *styloid process of the radius*, place the hand between pronation and supination, the thumb strongly abducted so as to render its extensors prominent. Then make a light incision, one inch in length, between the tendons of the two extensors, commencing at the lower extremity of the radius, and continued in a line with the axis of the first metacarpal bone. Avoid the superficial vein of the thumb. Draw the extensor *ossis metacarpi pollicis* outward, and the extensor *secundi internodii pollicis* inward, thus bringing into view the artery and its accompanying veins (Fig. 493).

LIGATION OF THE ULNAR ARTERY.—The ulnar artery is the larger of the two terminal branches of the brachial. It crosses the forearm obliquely to the commencement of its middle third; it then descends on the ulnar side of the limb to the wrist, crosses over the annular ligament, and forms the superficial palmar arch, which terminates by inosculating with the superficialis

volæ. Its course, in its lower part, is indicated by a line drawn from the inner condyle of the humerus to the external side of the pisiform bone.

Operation in the Upper Third.—The forearm should be in a supine position, with the hand strongly extended and inclined to the radial side. (1) The

Fig. 494.

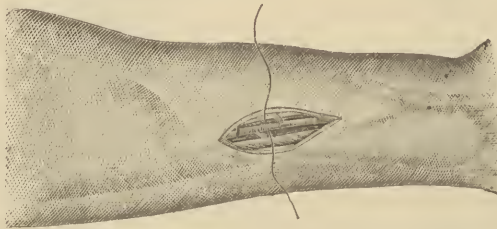


Ligation of the ulnar artery at the junction of the upper and middle thirds of the forearm. (Sédillot.)

cutaneous incision commences 3 centimetres (about $1\frac{1}{4}$ inches) below the fold of the elbow, and runs 4 centimetres (about $1\frac{1}{2}$ inches) along a line, which, in the supine position, separates the ulnar from the central third of the anterior surface of the forearm (Fig. 494). (2) After *dividing the fascia* of the forearm, the interval between the bellies of the flexor carpi ulnaris and flexor sublimis digitorum is to be sought for, and enlarged with the tip of the index finger and a blunt hook. (3) At the bottom lies the *artery*, with its *venæ comites*; on its ulnar side lies the ulnar nerve (Esmarch). Isolate the artery by flexing the forearm slightly, and the hand strongly. Pass the needle from within outward.

Operation in the Lower Third.—The ulnar artery, in the lower third, is covered by the deep fascia, and has upon its inner or ulnar side the flexor carpi ulnaris and ulnar nerve, and upon its outer side the flexor sublimis digitorum. Place the forearm supine, and extend the hand so as to make prominent the tendon of the flexor carpi ulnaris. (1) The *cutaneous incision* is made 3 centimetres (about $1\frac{1}{2}$ inches) in length, on the radial side of the tendon of the flexor carpi ulnaris, which is inserted into the pisiform bone (Fig. 495).

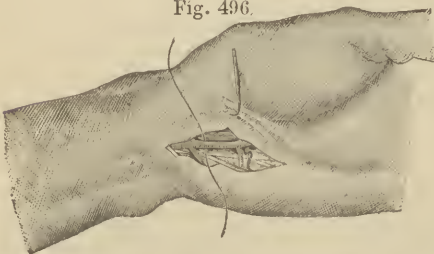
Fig. 495.



Ligation of the ulnar artery above the wrist. (Sédillot.)

(2) The *superficial layer of the fascia* of the forearm is to be cautiously divided; in like manner the *deep layer*. (3) The *artery*, accompanied by two veins (*venæ comites*), lies between the tendons of the flexor carpi ulnaris and the innermost tendon of the flexor sublimis digitorum. On its ulnar side lies the ulnar nerve (Esmarch).

Fig. 496.



Ligation of the ulnar artery below the pisiform bone. (Sédillot.)

Operation below the Os Pisiforme.—At the wrist, the artery runs on the radial side of the pisiform bone. The hand being turned backward, make a slightly curved incision about two inches in length and with concavity looking inward, on the radial side of the pisiform bone, through the skin and adipose tissue. The artery is

seated deeply in a groove, and the dissection should be continued along the side of the os pisiforme until the vessel is brought into view. The latter part of the dissection will be facilitated by slightly flexing the hand (Fig. 496). Pass the needle under the artery from within outward.

LIGATION OF THE ABDOMINAL AORTA.—The abdominal aorta lies in front, and rather to the left side, of the bodies of the vertebræ, having the vena cava ascendens on its right side, the sympathetic nerve on its left, and the left lumbar veins behind. It may be ligatured about one inch above its bifurcation at the fourth lumbar vertebra.

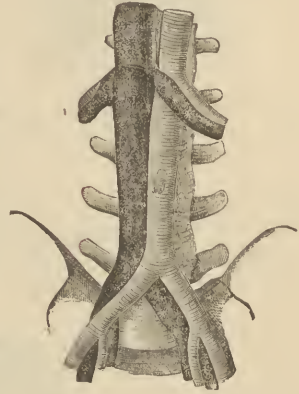
Cooper's Operation (Fig. 497).—Place the patient on his back, with knees drawn up and legs flexed. Make an incision, three inches in length, along the linea alba, the middle of it being on a level with the umbilicus, but a little to the left thereof, and open the peritoneum. Push the intestines aside, find the artery by its pulsations, and with a finger nail scratch through the peritoneum covering it on the left side. Pass the needle from left to right, taking care not to embrace the sympathetic nerve, and not to injure the vena cava.

Murray's Operation.—Murray made an elliptical incision on the left side, six inches in length, from the cartilage of the tenth rib downward, and with its concavity forward, to within an inch of the anterior superior spinous process of the ilium. The tissues were then carefully divided to the peritoneum, which was raised from the iliac fossa and psoas muscle, when, with great difficulty, and by scratching with the end of a director as well as with the finger nails, room was made to pass the ligature around the artery, which was tied three or four lines above its bifurcation. The patient died in twenty-three hours.

The abdominal aorta was ligatured for the first time in 1817 by Sir Astley Cooper. Next it was ligatured by James, of Exeter, in 1829; by Murray, at the Cape of Good Hope, in 1834; by Monteiro, at Rio Janeiro, in 1842; by South, in 1856; and since that time by Hunter McGuire, of Richmond (1868), by Stokes, by Watson, and by both Czerny of Vienna and Czerny of Heidelberg, making in all ten operations with ten deaths. The most interesting of these cases was Monteiro's, in which the aorta was tied for a large false aneurism on the lower and right side of the abdomen. The incisions were made much as in Murray's case, and the artery was ligatured with great difficulty. The patient died from secondary hemorrhage on the tenth day.

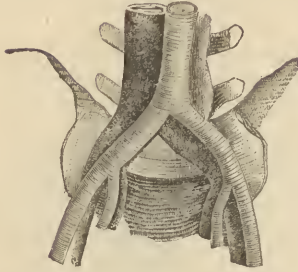
LIGATION OF THE COMMON ILIAC ARTERY.—*Surgical Anatomy.*—The common iliac arteries begin at the bifurcation of the abdominal aorta on the left side of the body of the fourth lumbar vertebra, a point directly behind the left side of the umbilicus. They vary in length from three-fourths of an inch to three inches, averaging about two inches (L. Holden). They diverge from each other, and run downward and outward on each side to the margin of the pelvis opposite the sacro-iliac synchondrosis, where they in turn each divide into the external and internal iliac arteries. The artery on the right side has on an average the same length as the artery on the left side (L. Holden). But the surgical relations of the two arteries are not identical.

Fig. 497.



To illustrate Cooper's method of tying the abdominal aorta. (Sé-dillot.)

The right common iliac artery is covered in front by the peritoneum, the ileum, and, at its termination, by the ureter. The two common iliac veins pass behind it, and, near its origin, the inferior vena cava and the right common iliac vein lie on its outer side.



Showing the relation of the common, external, and internal iliac arteries to their accompanying veins. (Sédillot.)

The left common iliac artery is covered anteriorly by the peritoneum, the rectum, and the superior hemorrhoidal artery, and, at its termination, by the ureter. The left common iliac vein is on the inner side and also behind the artery (Fig. 498).

Operation.—Place the patient on his back, but inclining to the opposite side. The course of the vessel can be ascertained by drawing a line from the umbilicus to the middle of Poupart's ligament. Make an incision through the integuments and superficial fascia, commencing just anterior to the end of the eleventh rib, downward, one inch and a half within the anterior superior spinous process of the ilium, and terminating just above the internal abdominal ring by a sharp curve upward and inward (Fig. 499).

Fig. 499.



Showing an operation performed by Surgeon J. Cooper McKee, U. S. Army, for tying the left internal and common iliac arteries. From a photograph of the cadaver. The wound of operation was seven inches in length. For an account of the case, see *Medical and Surgical History, etc.* Second Surgical Volume, p. 334.

The entire length of the incision is about seven inches. Next divide the three abdominal muscles, and cautiously separate the fascia transversalis from the peritoneum, beginning at the upper part of the wound where the adhesion is slightest. Now gently raise the peritoneum from the iliac fossa, and press it inward toward the pelvis. Find the external iliac artery by its pulsations, and carry the finger along that vessel, still detaching the peritoneum, until the common trunk is reached. Then the ureter, in front, is carefully pushed aside, and the needle is passed from within outward.

There is great danger of tearing the peritoneum while effecting the detach-

ment of it from the fascia transversalis; and, in order to avoid this accident, the work of separating the fascia transversalis from it should be begun high up in the wound of operation, where the attachments are the weakest. Again, there is great danger of rupturing the peritoneum while separating it from the iliac fossa; and, in order to avoid this accident, the peritoneum, with the intestines inclosed therein, should be cautiously raised up on the palms of an assistant standing on the other side of the patient, while the operator, with his fingers, gently severs the attachments.

The common iliac artery was ligatured for the first time in 1812, by Professor William Gibson, of Philadelphia, for hemorrhage from a gunshot wound; but the patient died, thirteen days after the operation, from a renewal of the bleeding. This artery was ligatured for aneurism for the first time in 1827, by Dr. Valentine Mott, of New York; the patient recovered. The statistics which have been collected show that the common iliac artery has been ligatured about sixty-eight times, with only sixteen recoveries.

LIGATION OF THE INTERNAL ILIAC ARTERY.—*Surgical Anatomy.*—The internal iliac artery issues from the common iliac at the sacro-iliac synchondrosis. It runs downward and forward to the upper margin of the great sacro-sciatic foramen. It usually is about one inch and a half in length. It is in relation, anteriorly, with the ureter, which separates it from the peritoneum; posteriorly, with the internal iliac vein and the lumbo-sacral nerve; it rests on the sacral plexus of nerves and the pyriformis muscle; on the left side it is overlapped by the rectum.

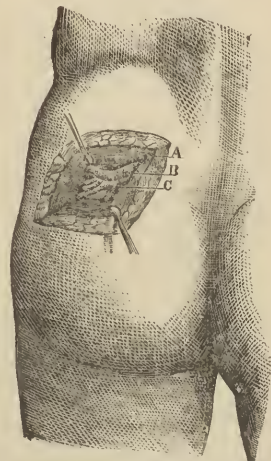
Operation.—The steps of the procedure required to expose the internal iliac artery are identical with those employed to expose the common iliac artery (Fig. 479). The needle should be passed from within outward, keeping its point close to the artery, to avoid injuring the internal iliac vein, which lies behind and to the inner side of it. The internal iliac artery may also be ligatured by making an incision five inches in length, half an inch outside of, and parallel to, the epigastric artery, as was practised by Stevens. Finally, it may be ligatured by making an elliptical incision seven inches in length, commencing two inches to the right or left of the umbilicus, according to the case, and ending near the external abdominal ring, with its convexity toward the ilium (White).

The internal iliac artery was ligatured for the first time in 1812, by Stevens, of Santa Cruz; the operation proved successful. Since his time, the operation has been frequently repeated, the whole number of cases being about twenty-seven, with eight recoveries.

LIGATION OF THE GLUTEAL ARTERY.—*Surgical Anatomy.*—The gluteal artery emerges from the pelvis, through the upper margin of the great sacro-sciatic foramen, and at the upper border of the pyriformis muscle. It is covered by the gluteus maximus muscle. It is accompanied by two veins, and by the gluteal nerve.

Operation.—A line drawn from the posterior superior spinous process of the ilium to the apex of the trochanter major indicates the course of the artery. Place the patient on his belly, with his thigh extended. Make an incision four or five inches in length, on the line just mentioned, through

Fig. 500.



Ligation of the left gluteal artery. (Follin.) A. Gluteus maximus. B. Gluteal artery. C. Gluteal veins.

the skin and subcutaneous adipose tissue (Fig. 500). It will run parallel with the fibres of the gluteus maximus muscle, which should be separated, and a finger introduced, in order to find the artery by its pulsations. Then separate the piriformis and gluteus medius muscles, between which it lies, and the borders of which cover it. Isolate the artery from its venæ comites, and pass the ligature around it, taking care not to include the gluteal nerve.

The gluteal artery was tied in 1808 by Bell, and in 1833 by R. Carmichael; since that time the procedure has been repeated by several others, and may now be considered an established operation.

LIGATION OF THE ISCHIATIC ARTERY (Fig. 501).—*Surgical Anatomy.*—The ischiatic artery escapes from the pelvis through the great sacro-ischiatic foramen, between the piriformis and coccygeus muscles, and descends in the interval between the trochanter major and the tuberosity of the ischium.

Fig. 501.



Ligation of the ischiatic artery.

It is separated from the gluteal artery by the piriformis muscle, and is covered by the gluteus maximus. It is accompanied by the ischiatic nerves, and by a vein which lies at its posterior and inner side.

Operation.—The centre of a line drawn from the posterior superior spinous process of the ilium to the tuberosity of the ischium, indicates the point where the artery passes out from the pelvic cavity. Place the patient upon his belly. Make a longitudinal incision two inches long, the centre of which corresponds to the point of emergence of the artery, as just described.

Divide successively the skin, the cellulo-adipose tissue, and the fibres of the gluteus maximus muscle. The artery is to be found on the inner side of the nerves, and must be carefully separated from the vein. The position of the artery is to be ascertained by inserting a finger into the wound and feeling its pulsations.

LIGATION OF THE INTERNAL PUDIC ARTERY (Fig. 502).—*Surgical Anatomy.*—

Fig. 502.



Ligation of the internal pudic artery.

The internal pudic artery is the smaller of the two terminal branches of the anterior trunk of the internal iliae. It descends in front of the ischiatic artery to the lower border of the great sacro-ischiatic foramen. It emerges from the pelvis through the great sacro-ischiatic foramen, below the piriformis muscle, crosses the spine of the ischium, and re-enters the pelvis through the lesser sacro-ischiatic foramen; it then crosses the internal obturator muscle to the ramus of the ischium, being situated about an inch from the margin of the tuberosity, and bound down by the obturator fascia; it next ascends the ramus of the ischium, enters between the two layers of the deep perineal fascia, and rises along the ramus of the os pubis. At the symphysis it pierces the anterior layer of the deep perineal fascia; and, very much lessened in size, it reaches the dorsum of the penis, along which it runs to supply that organ, under the name of the *arteria dorsalis penis*.

Operation.—(1) The artery may be ligatured on its emergence from the great sacro-ischiatic foramen by making the same incisions as those employed for exposing the ischiatic artery; the pudic artery is found a little internal thereto, accompanied by its venæ comites and by the internal pudic nerve.

(2) The artery may be ligatured, in the perineum, as it ascends the ramus of the ischium and os pubis. Draw a line from the middle of the pubes to the inner border of the tuber ischii. Place the patient in the position for lithotomy; make an incision two inches in length along the ramus of the pubis, near the arch; by careful dissection the artery is found running along the inner border of the ramus, where it may be separated from its venæ comites and the internal pudic nerve, and where a ligature may be applied. Care must be taken not to wound the corpus cavernosum.

LIGATION OF THE ARTERIA DORSALIS PENIS.—This artery attains the dorsum of the penis by ascending between the two crura and the symphysis pubis, and runs forward, through the suspensory ligament, in the groove of the corpus cavernosum to the glans, distributing branches in its course to the body of the organ and to the integuments. It is enveloped in the subcutaneous fascia; and is accompanied by the dorsalis penis nerve and vein, which structures must not be injured in exposing and ligaturing the artery.

Operation.—Make an incision three-fourths of an inch in length, commencing two inches in front of the pubes, and exactly in the median line, through the skin and the superficial lamina of the subcutaneous layer. Thereby the artery is fully exposed. Pass a small artery needle around it, carefully avoiding the vein and the nerve which accompany it.

LIGATION OF THE EXTERNAL ILIAC ARTERY.—*Surgical Anatomy.*—The external iliac artery, on each side, runs obliquely downward along the inner border of the psoas muscle, from a point opposite the sacro-iliac synchondrosis to the femoral arch, where it becomes the femoral artery. In front it is in relation with the spermatic vessels, the peritoneum, and a thin layer of fascia, derived from the iliac fascia, which envelops the artery and the accompanying vein. At its commencement it is crossed by the ureter; and, near its termination, by the crural branch of the genito-crural nerve, and the circumflex iliac vein. Posteriorly, it is in relation with the external iliac vein, which gradually passes to its inner side, where it is found at the femoral arch. Externally, it lies against the psoas muscle, from which it is separated by the iliac fascia. Internally, below, passes the vein, as just stated; and, curving along its side, the vas deferens. It is surrounded throughout its entire course by lymphatic vessels and ganglia. Near its termination it sends off two branches, the epigastric and the circumflex iliac arteries. It is about four inches in length, and its course corresponds to a line drawn from the left side of the umbilicus to a point midway between the anterior superior spinous process of the ilium and the symphysis pubis. It may be ligatured in any part of its course, excepting at its upper and lower extremities.

Abernethy's Operation.—An incision about three inches in length was made through the integuments, in the direction of the artery, beginning a little above Poupart's ligament, and more than half an inch on the outside of the upper part of the abdominal ring, to avoid the epigastric artery. The aponeurosis of the external oblique muscle being exposed, was next divided in the direction of the external wound. The lower part of the internal oblique muscle was thus uncovered, and the finger being introduced below the inferior margin of it and of the transversalis muscle, they were divided with the crooked bistoury for about one inch and a half. Mr. Abernethy now introduced his finger beneath the bag of the peritoneum, and carried it upward

by the side of the psoas muscle, so as to touch the artery about two inches above Poupart's ligament. He took care to disturb the peritoneum as little as possible, detaching it to no greater extent than was requisite to admit his two fingers to touch the vessel. The pulsations of the artery made it clearly distinguishable. By means of an eyed probe two ligatures were conveyed under the vessel; one of them was carried upward as far as the artery had been detached, and the other downward; they were firmly tied, and the vessel was divided in the interspace between them.¹ Stevens, of Santa Cruz, tied the internal iliac by an operation which was substantially the same as that of Abernethy.

Sir Astley Cooper's Operation.—A semilunar incision is to be made through the integuments in the direction of the fibres of the aponeurosis of the external oblique muscle (Fig. 503). One extremity of this incision will be

Fig. 503.



Sir A. Cooper's operation for tying the external iliac artery. (Sédillot.)

situated near the anterior superior spinous process of the ilium; the other will terminate a little above the inner margin of the abdominal ring. The aponeurosis of the external oblique muscle will be exposed, and is to be divided throughout the extent and in the direction of the external wound. The flap which is thus formed being raised, the spermatic cord will be seen passing under the margin of the internal oblique and transverse muscles. The opening in the fascia which lines the transverse muscle, through which the spermatic cord passes, is situated in the mid-space between the anterior superior spinous process of the ilium and the symphysis pubis. The epigastric artery runs precisely along the inner margin of this opening, beneath which the external iliac artery is situated. If, there-

fore, the finger be passed under the spermatic cord through this opening in the fascia which lines the transverse muscle, it will come into immediate contact with the artery, which here lies on the outside of the external iliac vein. The artery and vein are connected together by dense cellular tissue, which must be separated to enable the operator to pass a ligature, by means of an aneurism-needle, between them and around the artery.² Care must be taken to avoid the epigastric artery, which runs near the inner part of the incision. Dupuytren, while performing this operation at the Hôtel-Dieu, in the autumn of 1821, wounded the epigastric artery. The hemorrhage was so copious that two ligatures were required. Death from peritonitis ensued.

Appreciation.—Mr. Norman, of Bath, after trying both modes of operating, found that employed by Sir Astley Cooper a more easy way of finding the artery than the longitudinal incision practised by Mr. Abernethy. Samuel Cooper and M. Roux both came to the same conclusion. Mr. Todd, also, after repeated trials of Mr. Abernethy's and Sir A. Cooper's methods on the cadaver, concluded that the plan recommended by the latter afforded the greater facility of applying the ligature to the artery, because more room was obtained by it, and with less disturbance of the peritoneum. For these reasons Cooper's method of ligaturing the external iliac artery, or some slight modification of his method, has almost universally been preferred by sur-

¹ Surgical Observations, 1804.

² Hodgson, Diseases of Arteries, etc., pp. 421, 422. London, 1815.

geons of the past and present generations.¹ One of the best of these modifications is very clearly and tersely described as follows:—

Esmarch's Operation.—(1) The *cutaneous incision*, which is 1 centimetre (about $\frac{2}{3}$ of an inch) above and parallel to Poupart's ligament, 8 to 10 centimetres (from $3\frac{1}{4}$ to 4 inches) in length, and slightly convex, begins 3 centimetres (about $1\frac{1}{8}$ inches) to the inner side of the anterior superior iliac spine, and ends opposite the internal inguinal ring (without exposing the ring or the spermatic cord). (2) The subcutaneous tissue, the thin superficial fascia, the strong tendinous aponeurosis of the *external oblique*, and the muscular fibres of the *internal oblique* are divided; then the horizontal muscular fibres of the *transversalis* in the outer angle of the wound. (3) The thin subjacent *fascia transversalis* must be carefully divided. (In fat subjects there is still a thin layer of fat). (4) The *peritoneum* is carefully pressed toward the umbilicus with the fingers bent like a hook (taking care not to strip up the iliac fascia from the pelvic wall and with it the artery). (5) The *artery* lies in contact with the inner border of the psoas muscle; to its inner side is the vein; to the outer side the anterior crural nerve covered by the iliac fascia; the genital branch of the genito-crural nerve crosses the artery obliquely.² Open the *sheath* cautiously and insinuate the needle beneath the artery, from within outward, to avoid the vein.

The external iliac artery was ligatured for the first time, in 1796, by Mr. Abernethy, for inguinal aneurism, a disorder which previously had always been deemed incurable. He lost his first two cases, but saved the third and fourth. The operation was first performed in America by Dr. Dorsey, of Philadelphia. During our civil war this artery was ligatured 16 times with only two successes, but this enormous fatality was due not as much to the hazards attending the operation itself, as to the inutility of tying main arterial trunks for shot-lesions of their branches, instead of securing the injured vessels themselves with both proximal and distal ligatures at the seat of the injury; for nearly two-thirds recover when the external iliac artery is ligatured for other causes, 169 recorded cases having given in all but 61 deaths.

LIGATION OF THE EPIGASTRIC ARTERY.—The epigastric artery arises from the anterior face of the external iliac three or four lines above Poupart's ligament. At first it descends; then, passing forward between the peritoneum and the *transversalis fascia*, it ascends obliquely in a line drawn from the middle of Poupart's ligament to the umbilicus, to the border of the sheath of the rectus. This sheath it enters near the lower third thereof, passes upward behind the rectus muscle, to which it is distributed; and in the substance of that muscle ends by inosculating, near the ensiform cartilage, with the termination of the internal mammary artery. It lies behind the inguinal canal, to the inner side of the internal abdominal ring, and immediately above the femoral ring. It is crossed near its origin by the vas deferens in the male, and by the round ligament in the female. It is accompanied by two veins, almost to its origin.

Operation.—Make an incision through the integuments, two and a half or three inches in length, and half an inch above and parallel to Poupart's liga-

¹ In one instance, however, where I tied the right external iliac artery for inguinal aneurism in a woman, aged about 30, I uncovered the artery, and brought it fully into view by Liston's modification of Abernethy's method, without any difficulty whatever. The wound healed kindly, although the ligature was rather late in coming away; but, after a time, pulsation unhappily reappeared in the tumor, and a relapse occurred. Stephen Smith, I believe, tied the common iliac in this case afterwards, with a fatal result from secondary hemorrhage. Still, I think Cooper's operation is to be preferred.

² Esmarch's Handbook, p. 155.

ment, to the middle whereof the middle of the wound should exactly correspond; one or two vessels in the superficial fascia will probably require ligation. Next, the tendinous aponeurosis of the external oblique should be raised and divided on a director, and then the lower border of the internal oblique and transversalis muscles raised, when, on tearing through the fascia transversalis, the artery will be exposed near its origin. In passing the needle around the artery, be careful not to include its *venae comites*.

The *circumflex iliac artery* may be exposed and tied by the same incisions. After tearing through the transversalis fascia, it will be found running parallel with, and close to, Poupart's ligament.

LIGATION OF THE FEMORAL ARTERY.—*Surgical Anatomy.*—The femoral



Fig. 504.

Showing the surgical anatomy of the femoral region. (Sédillot.)

artery descends the inner side of the thigh from the termination of the external iliac behind Poupart's ligament, at a point midway between the anterior superior spinous process of the ilium, and the symphysis pubis, to the opening in the adductor magnus, at the junction of the middle with the inferior third of the thigh, where it becomes the popliteal artery.

The femoral artery and vein are inclosed in a strong sheath, the *femoral* or *crural canal*, which is formed to a great extent by aponeurotic and areolar tissue, and by a process of fascia, sent inward from the fascia lata. Near Poupart's ligament, this sheath is much larger than the vessels it contains, and is continuous with the fascia transversalis and the iliac fascia. If the sheath be opened at this point, the artery will be seen to be situated in contact with the outer wall of the sheath. The femoral vein lies next the artery, but separated from it by a fibrous septum. Between the vein and the inner wall of the sheath, but separated from the vein by another thin fibrous sheath, there is a triangular space into which the sac is protruded in femoral hernia. This space is occupied, in the normal state of the parts, by loose connective tissue and by lymphatic vessels, which pierce the inner wall of the sheath, to proceed to a gland situated in the femoral ring.

Relations.—The upper third of the femoral artery is superficial, being covered only by the skin, the inguinal glands, and the superficial and deep fasciæ. The lower two-thirds is covered by the sartorius muscle. To its outer side, the artery is first in relation with the psoas and iliacus, and then

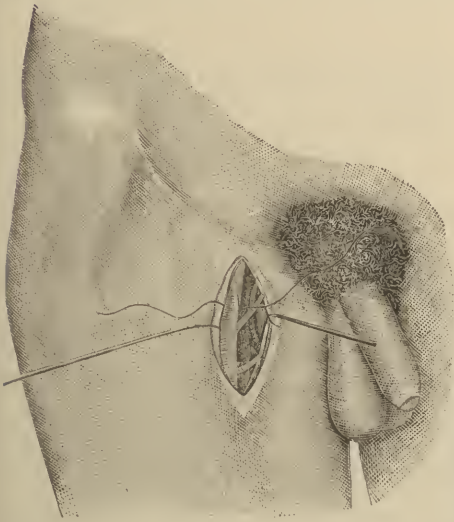
with the vastus internus. Behind, it rests upon the inner border of the psoas muscle; it is next separated from the pectineus by the femoral vein, and profunda vein and artery, and then lies on the adductor longus as far as its termination. Near the lower border of the adductor longus it enters an aponeur

rotic canal, formed by an arch of tendinous fibres, thrown from the border of the adductor longus and the border of the opening in the adductor magnus, across to the side of the vastus internus. To its inner side, it is in relation at its upper part with the femoral vein, and, lower down, with the pectineus, adductor longus, and sartorius.

The immediate relations of the artery are the femoral vein and two saphenous nerves. The vein at Poupart's ligament lies to the inner side of the artery; but, lower down, it gets altogether behind, and inclines to its outer side. The short saphenous nerve lies at the outer side, and somewhat upon the sheath for the lower two-thirds of its extent. The long saphenous nerve is situated within the sheath, and in front of the artery to the same extent. The *course* of the femoral artery is indicated by a line drawn from a point midway between the anterior superior spinous process of the ilium, downward and inward to the inner side of the internal condyle of the femur.

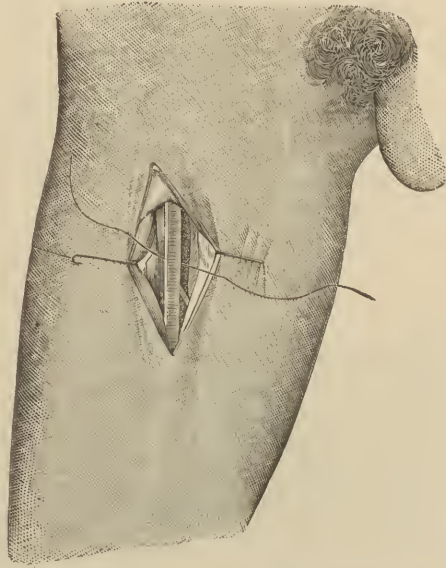
Operation on the Common Femoral Artery.—(1) The *cutaneous incision* commences at a point midway between the anterior superior spine of the ilium and the symphysis pubis, two millimetres (one line) above Poupart's ligament, and is carried downward for five centimetres (about two inches). (2) The *superficial fascia* is divided. (3) The subcutaneous tissue is divided; the lymphatic ganglia are avoided by drawing them aside or by removing them. (4) Division of the *fascia lata*. (5) The *sheath of the vessels* is opened one centimetre (about three-eighths of an inch) below Poupart's ligament, because immediately below this point the superficial epigastric and superficial circumflex iliac arteries are given off (Fig. 505). (6) The femoral vein lies on the inner side of the artery, and the anterior crural nerve on the outer side (Esmarch). Pass the needle from within outward.

Fig. 505.



Ligation of the common femoral artery. (Sédillot.)

Fig. 506.



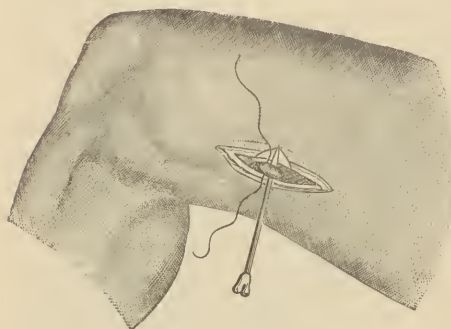
Ligation of the superficial femoral artery at the apex of Scarpa's triangle. (Sédillot.)

Operation on the Superficial Femoral Artery at the Apex of Scarpa's Triangle (Fig. 506).—(1) The *cutaneous incision*, five centimetres (about two inches) in length, at the inner border of the sartorius, commences six finger-breadths (eight to ten centimetres, or from three to four inches) below Poupart's liga-

ment. (2) The *border of the sartorius* is exposed and drawn outward. (3) The *sheath* is opened. The femoral vein lies to the inner side and somewhat behind the artery; the anterior crural nerve is on the outer side (Esmarch). Pass the needle from within outward, keeping its point close to the artery to avoid the femoral vein. Should the saphenous vein be wounded, it must be ligatured, since the use of pressure to stop the bleeding might interfere with the collateral circulation.

Operation on the Superficial Femoral at its Lower Third.—Here the artery enters a fibrous sheath formed by bands which extend from the vastus internus

Fig. 507.



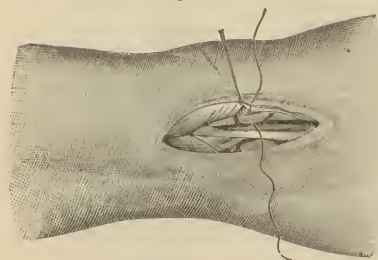
Ligation of the femoral artery in the tendinous canal of the adductor muscles. (Sédillot.)

opening the canal, the artery is brought into view; upon it runs the saphenous nerve, and behind it the femoral vein (Esmarch). The vessels are united by very dense connective tissue, and much caution must be used in isolating the artery.

LIGATION OF THE POPLITEAL ARTERY.—The popliteal artery commences at the opening in the adductor magnus muscle, and passes obliquely downward and outward, through the middle of the popliteal space, to the lower border of the popliteus muscle, where it divides into the anterior and posterior tibial arteries (Fig. 508).

Operations.—(1) To ligature the artery in the upper part of its course, make an incision three inches in length, beginning at the inferior third of the thigh, and continuing along the external margin of the semi-membranosus muscle. Divide the skin and fasciæ. Separate the connective tissue with the finger and director. Now flex the leg, and first the popliteal nerve appears; next the popliteal vein, to its inner side, and, lastly, the artery itself. Pass the needle from within outward.

Fig. 508.



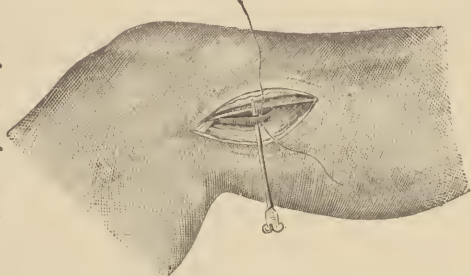
Ligation of the popliteal artery in the lower part of the popliteal space. (Sédillot.)

(2) To ligature the artery in the lower part of its course (Fig. 508), place the patient on his belly with the leg extended. Make an incision through the skin, three inches long, somewhat to the outer side of the median line. The external saphenous nerve which lies under the skin must be avoided. Cautiously divide the fascia, and then the cellulo-adipose tissue between the heads of the gastrocnemius is to be separated with the finger, so as to expose the popliteal

nerve, the popliteal vein, and the artery. The nerve and vein are to be drawn inward, and the needle passed from within outward.

(3) To ligature the popliteal artery below the internal condyle of the tibia, semiflex the leg, and lay it upon the outer side. The operator, standing on the external side of the limb, should feel for the internal side of the muscular mass which bounds the popliteal space internally and below. He makes an incision, two and a half inches in length, from above downward, from without inward, and from behind forward, along the edge of the internal head of the gastrocnemius muscle, within half an inch of the internal border of the tibia (Fig. 509), taking care to avoid the internal saphenous vein. He then divides the crural aponeurosis a little further back than the skin, and introduces a finger to break down the intermuscular septum, the leg being flexed on the thigh to relax the muscles. Fig. 509 represents the nerve as seen at the bottom of the wound, the artery to the inner side, and the accompanying vein drawn outward.

Fig. 509.



Ligation of the popliteal artery below the inner condyle of the tibia. (Sédillot.)

LIGATION OF THE POSTERIOR TIBIAL ARTERY.—The posterior tibial artery passes obliquely downward along the tibial side of the leg, from the bifurcation of the popliteal artery at the lower border of the popliteus muscle to the concavity of the os calcis, where it divides into the internal and external plantar arteries. Its course is indicated by a line drawn from the centre of the popliteal space to a point just behind the inner malleolus.

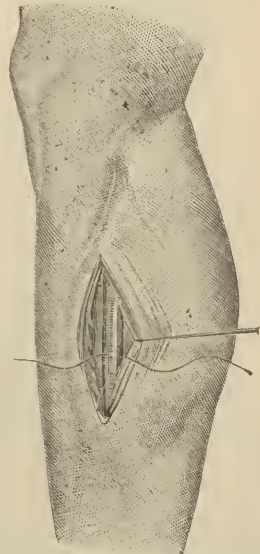
In the *upper third* of the leg, the artery lies very deep, being covered by the tibialis posticus, the deep fascia, the soleus, and the gastrocnemius, as well as by the skin and superficial fascia.

Operation.—At a distance of two-thirds of an inch from the inner edge of the tibia, make an incision not less than four inches in length, through the integuments and deep fascia; with the index finger in the wound, detach and push outward the inner head of the gastrocnemius, and likewise separate the attachments of the soleus, thus exposed, from the posterior surface of the tibia; next, whilst an assistant draws this muscle backward and outward with a blunt hook, divide the deep layer of the crural fascia upon a director, and search for the artery immediately underneath; separate the artery from its venæ comites and from the posterior tibial nerve, and be careful not to include either of them while passing the needle around the artery.

In the *middle third* of the leg, the artery lies more superficial, running parallel to the inner edge of the tibia, from which it is separated by the flexor longus digitorum muscle. It is covered by the internal border of the soleus. It is accompanied by two veins, and the posterior tibial nerve here lies on its inner side.

Operation.—Three-fourths of an inch behind the inner edge of the tibia, make an incision parallel

Fig. 510.



Ligation of the posterior tibial artery at the middle third of the leg. (Sédillot.)

thereto, three inches in length, through the integuments and deep fascia. The border of the gastrocnemius is to be drawn backward, so as to expose the soleus (Fig. 510). Divide the fibres of the soleus on a director; the artery is now felt pulsating about an inch from the edge of the tibia. Next, divide the pearl-colored deep aponeurosis which covers it, and then relax the muscles by changing the position of the leg. Separate the artery from its venæ comites, and press the nerve to the outer side. Pass the needle from without inward, carefully avoiding the veins and the nerve.

In the *lower third* of the leg, the artery descends behind the inner malleolus, running at first parallel to the tendo Achillis, and then midway between the inner malleolus and the tuberosity of the os calcis. It is quite superficial, and in relation anteriorly with the tendons of the tibialis posticus and flexor longus digitorum, and, posteriorly, with the posterior tibial nerve. On each side of it lies one of the venæ comites.

Operation.—Having placed the leg on its outer side, and extended the foot, make an incision two inches in length, a finger's breadth behind the inner edge of the tibia, and parallel to it, through the skin and superficial fascia. Raise the deep fascia on a grooved director and divide it. Now, turn aside some adipose tissue, and the artery with its venæ comites and the posterior tibial nerve will be brought into view (Fig. 511). The sheaths of tendons must be carefully avoided. It is to be observed that sometimes the artery lies anterior to the cutaneous incision above directed.

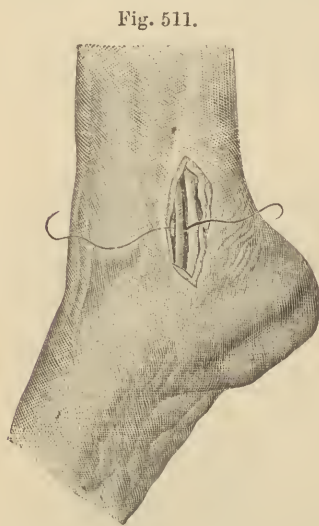


Fig. 511.

Ligation of the posterior tibial artery at the lower third of the leg. (Sédillot.)

At the *inner side of the ankle*, the artery may be ligatured by making a curved incision one inch and a half in length, midway between the inner malleolus and the tendo Achillis. Having divided the skin and superficial fascia, the deep fascia must be raised on a grooved director and freely opened. Immediately underneath should be found the artery, together with the tendons of the tibialis posticus and flexor longus digitorum muscles on the inner side, and the posterior tibial nerve, together with the tendon of the flexor longus pollicis muscle, on the outer side of the vessel. Separate the artery from its

venæ comites, etc., and pass the needle around it from without inward, taking care to embrace nothing else.

In the lower third of the leg, there are numerous anastomoses formed by large branches of the internal saphenous vein, which in general run transversely; these may be revealed by compressing the trunk of the vein above them, so that injury to them may as much as possible be avoided.

LIGATION OF THE PERONEAL ARTERY.—The peroneal artery arises from the posterior tibial, from one to two inches below the inferior border of the popliteus muscle; it is nearly as large as the anterior tibial artery, and descends obliquely outward to the fibula. It then runs downward along the inner border of the fibula to its lower third, where it divides into the anterior and posterior peroneal artery. As it descends, however, it diminishes in size so rapidly that, below the middle of the leg, it is too small to require a formal deligation.

Operation.—Make an incision two and a half inches long over the external border of the fibula, terminating opposite its middle. Divide consecutively the skin, superficial fascia, and deep fascia, whereby the origin of the soleus muscle will be brought into view. This must be detached and drawn inward, when the border of the fibula will be distinctly exposed. The operator now divides the fibres of the flexor longus pollicis, and separates them from the posterior surface of the fibula, at the inner surface of which will be found the artery, at the point where the interosseous membrane joins the bone.

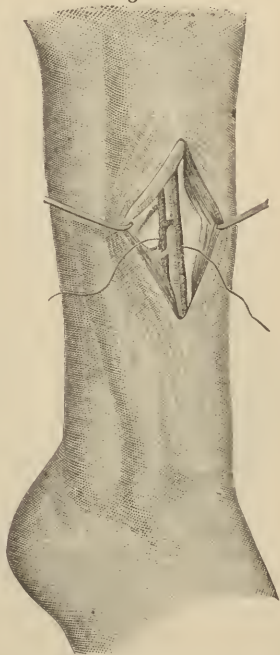
LIGATION OF THE ANTERIOR TIBIAL ARTERY.—The anterior tibial artery passes forward between the two heads of the tibialis posticus muscle, and through the opening in the upper part of the interosseous membrane, to the anterior tibial region. It then descends the anterior aspect of the leg to the ankle-joint, where it becomes the arteria dorsalis pedis.

Relations.—In its downward course it rests upon the interosseous membrane—to which it is connected by a small tendinous arch that is thrown over it—upon the lower part of the tibia, and upon the anterior ligament of the joint. In the upper third of its course it is situated between the tibialis anticus and extensor longus digitorum; lower down between the tibialis anticus and extensor proprius pollicis; and just before it reaches the ankle-joint, it is crossed by the tendon of the extensor proprius pollicis, and becomes placed between that tendon and the tendons of the extensor longus digitorum. Its immediate relations are with the venæ comites and the anterior tibial nerve, the latter of which lies at first to its outer side, and, about the middle of the leg, becomes placed superficially to the artery. The course of the artery is indicated by a line drawn from the inner border of the fibula, above, to a point midway between the two malleoli, below.

Operation at the Upper Third.—Having turned the limb inward, and extended the foot, take as a guide the line just mentioned, or a point ten lines to the outer side of the spine of the tibia, and make an incision four inches in length through the integuments. Divide the deep fascia by a cruciform incision to allow its complete separation. The intermuscular septum is now to be sought for, and may be recognized (*a*) as the first intermuscular space from the tibia; (*b*) on pressure from within outward, by the resistance of the other muscles; (*c*) at the lower part of the incision, by the white line of the muscular interspace being more marked. The foot being flexed, separate the muscles with the index finger; and, the margins of the wound being drawn apart by retractors, expose the artery with its venæ comites and the anterior tibial nerve, the latter of which is outside. Pass the needle from without inward.

Operation at the Middle Third.—In this part of its course the artery is covered by the skin, the superficial, and the deep fascia. On the inner side it has the tibialis anticus muscle, and, on the outer, the extensor longus digitorum and the extensor proprius pollicis (Fig. 512). Having placed the limb in the same position as directed above, make an incision three and a half inches in length, along the course of the artery, and through the integu-

Fig. 512.

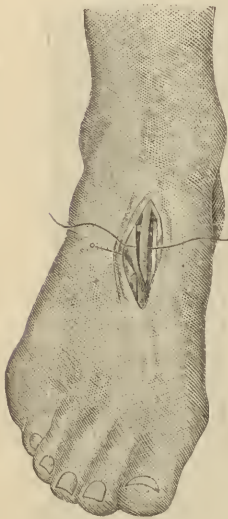


Ligation of the anterior tibial artery at the middle third of its course. (Sédillot.)

ments. The septum in the deep fascia is to be recognized by its white line. Divide it longitudinally, and likewise by a cruciform incision. Flex the foot to relax the muscles, when, the sides of the wound being separated by drawing the tibialis anticus inward, and the extensor longus digitorum and extensor proprius pollicis outward, the anterior tibial nerve is found lying more superficial than the artery and its accompanying veins. Pass the needle from within outward.

Operation at the Lower Third.—Here the artery is covered by the integument and the fasciæ, and is crossed by the tendon of the extensor proprius pollicis. Low down, it lies between the tendon of this muscle and the tendons of the extensor longus digitorum. It is accompanied by two veins and the anterior tibial nerve; the latter runs to the outer side. Having placed the leg in a horizontal posture and extended the foot, and having recognized the position of the tibialis anticus muscle, make an incision three inches in length, along the external border of that muscle, on the line already indicated, but not extending to the annular ligament. On a grooved director, carefully incise the deep fascia, and find the space between the tibialis anticus and tendon of the extensor proprius pollicis, and separate them with the index finger. Now flex the foot and expose the artery, which rests on the tibia with the nerve superficial to it. Separate the artery from the venæ comites, and pass the needle from within outward, the nerve being drawn inward. If the incision happen to fall between the tendon of the extensor proprius pollicis and the tendons of the extensor communis digitorum, the ligature may still be passed around the artery.

Fig. 513.



Ligation of the arteria dorsalis pedis. (Sédillot.)

LIGATION OF THE ARTERIA DORSALIS PEDIS.—The dorsalis pedis artery runs forward along the tibial side of the dorsum of the foot, from the ankle-joint to the great toe, where it divides into two branches, the dorsalis hallucis and the communicating. Its course corresponds to a line drawn from the middle of the inter-malleolar space to a point midway between the anterior extremities of the first two metatarsal bones. It is covered by the integument, the fasciæ, and the innermost tendon of the extensor brevis digitorum. On its inner side lies the tendon of the extensor proprius pollicis, and on its outer side the inner tendon of the extensor longus digitorum. It is accompanied by the veins, and externally by the anterior tibial nerve.

Operation.—Make an incision two inches in length, on the line above described (Fig. 513), parallel to the external border of the tendon of the extensor proprius pollicis. Divide the deep fascia on a grooved director. Draw the internal division of the extensor brevis digitorum outward, and the artery with its venæ comites will be exposed. The nerve lies on the outer side. Pass the needle from within outward.

SURGICAL DISEASES OF THE VASCULAR SYSTEM.

BY

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PHLEBITIS.

IN February, 1784, before the London "Society for the Improvement of Medical and Chirurgical Knowledge," John Hunter read a dissertation in which he described an adhesive, suppurative, and ulcerative inflammation of the lining membrane of veins, which he had observed as a result of amputations and other complicated surgical operations and injuries. Scientific literature, prior to this date, contains many descriptions of conditions which undoubtedly resulted from phlebitis (Aretæus, Paré, and others); but the morbid anatomy of this inflammatory process had never been so nearly understood and described before this observation of the great English surgeon. Following in the footsteps of Hunter, others, including Baillic, Bichat, Hodgson, Cooper, Travers, and Cruveilhier, contributed to the study of this important subject; but it was not until the more perfect construction of the microscope, in later years, rendered the accurate study of normal histology possible, that the true pathology of phlebitis was thoroughly understood.

DEFINITION AND MORBID ANATOMY.—*Phlebitis* means an inflammation of all the tissues which enter into the formation of the walls of a vein. *Endophlebitis*, *mesophlebitis*, and *periphlebitis* are terms used to designate the inflammatory process involving respectively the internal, middle, and external layers of the venous wall.

The progress of inflammation in the tissues of veins is closely analogous to that of the same process in all other structures, namely: irritation, hyperæmia, tumefaction, infiltration of the extra-vascular spaces with emigrant, embryonic, and pus-cells; the process terminating in cicatrization (often with adhesions), calcareous degeneration, suppuration, or gangrene. The mode of termination will depend upon the severity of the attack, the character of the lesion, and the power of resistance and recuperation existing in the tissues. The inflammatory process involves a tubular structure, the walls of which are composed of an inner layer (*intima*), made up of flat, polygonal cells (the endothelia), a middle layer chiefly made up of elastic tissue, and an outer layer, containing elastic loops, connective tissue, and unstriped muscle. Blood-vessels and nerves traverse the outer and middle tunics, following the bundles of connective tissue.

The cells of the lining membrane are smaller than the arterial endothelia, and are embedded in a fibrillated, intercellular substance (Cornil and Ranvier). The elastic and muscular tissues are less developed than in the arteries (Heitzmann). These are so irregularly arranged that any division into middle and

external coats is, in great part, artificial and imaginary. Moreover, many of the veins contain no muscular tissue, while their connective tissue varies in quantity in different parts of the body. The sinuses of the dura mater, the veins in bones, and those of the retina, have no muscular fibres, while the jugulars, subclavians, and *venæ cavae* have a relatively small quantity, or are entirely devoid of this tissue. Again, the arrangement of the muscular tissue differs in different veins. The inferior vena cava and the portal and renal veins have an inner, circular, and an external, longitudinal layer, while the femoral and popliteal veins have the longitudinal fibres more internal. This tissue is still more complicated in the saphenous veins, where the internal layers are arranged longitudinally, with a number of alternating, or transverse and longitudinal, layers placed externally to these.

The elastic layer begins immediately external to the basement substance which supports the endothelial layer, and is here somewhat isolated and well defined; but from the external surface of this central, elastic lamina springs a network of elastic fibres, through the loops and in the meshes of which are woven the muscular and connective-tissue fibres.

The vasa vasorum follow the connective-tissue bundles in their distribution to the tissues of the wall down to the elastic layer. Nerves from the sympathetic system have been demonstrated in the larger veins.

The valves are delicate reduplications of the internal coat, having a well-defined, elastic reticulum, especially on their distal or convex surface (Heitzmann), and muscular fibres at the point of attachment to the venous wall.

The vascular area—the outer and middle layers—is first concerned in the inflammatory process. The endothelial tunic, as a result of these structural changes, is subsequently involved in the process. It then appears cloudy, thickened, and rough, and may become separated in shreds. (Frey.)

In the vascular area, during the earlier stages, the capillaries of the vasa vasorum become swollen, the white corpuscles emigrate into the extra-vascular spaces, and the normal connective-tissue cells are stimulated into rapid proliferation, resulting in a thickening of the wall, due to the presence of these embryonic cells, and the excessive hyperæmia. As in arteritis, the vitality of the endothelial tunic becomes impaired, and it is more or less projected into the cavity of the vein, the endothelia undergoing rapid proliferation. After a few days, granulation-buds push out from this embryonic tissue of the endothelia, and new capillaries are developed in these granulation-masses, anastomosing and becoming a part of the circulation of the vasa vasorum, as well as leading into the coagulum which occupies the calibre of the vein.

At the point of contact of the outer surface of the thickened endothelial layer with the internal surface of the middle (elastic) layer, large sinuses are developed, which receive the blood from the capillaries of the middle tunic. These sinuses are lined with an endothelial layer, which rests upon the contiguous connective tissue. From these large vessels fine capillaries are given off, which permeate the thickened internal layer, and some of which pass into the organizing coagulum.

When a thrombus, caused by the sudden coagulation of the blood in a vein, is examined in its recent state, it is found to be composed of successive laminae of fibrin and corpuscles, and the more recent of these laminae are external. When the vein is first occluded by this sudden coagulation of the blood, the pressure from behind is so great that the coagulum is compressed toward its centre, while the current, more and more impeded in its progress, flows between the periphery of the clot and the inner surface of the vessel, adding layer by layer fresh deposits of coagulation upon the thrombus. A microscopical examination of such thrombi reveals a vast number of white

corpuscles in various stages of fatty degeneration, with layers of fibrin intervening.

If it were not that, flowing in contact with the surface of a vein undergoing an inflammatory process, was the blood, the integrity of which is necessary to tissue-life and welfare, the dangers from this condition would be slight; but experiments have shown that not only does this inflammatory process, by reason of its invasion of the intima, produce changes in the blood which lead to stasis, but that there is a dangerous endosmosis, into the blood-current, of septic matter, which, becoming a part of the current, is swept along and lodged in the various organs toward which it is leading (*emboli*), producing infarctions, abscesses, and, almost invariably, irreparable damage. The adhesion of the intima, and the formation of a fibrinous clot—which may completely occlude the vessel (*occlusion thrombus*), or may merely plaster over the endothelial tunic (*peripheral thrombus*)—are efforts, not always successful, to prevent endosmosis of septic matter.

The process of repair in tissues capable of successful resistance, in venous inflammation, is one of organization of the embryonic cells, fibrillation, and contraction, resulting in partial or complete occlusion. In tissues of low and impaired vitality, the progress of the inflammation is rapidly toward suppuration, usually terminating in septic fever and death. Microscopical sections from such specimens of phlebitis show that the leucocytes and embryonic cells have undergone retrogressive changes, and that the tissues are infiltrated with resulting pus corpuscles. Gangrenous spots are not infrequent, often opening into the calibre of the vessel, and allowing the influx of septic products, or the efflux of blood.

Since phlebitis is a frequent cause of thrombosis, and since venous thrombosis is the most frequent form of intra-vascular coagulation, a consideration of the pathogeny and pathology of this process must naturally find a place here. Virchow has endeavored to show that primitive phlebitis is extremely rare, and that when a clot is produced in a vein which is inflamed, the coagulation has more often preceded than followed the inflammation. Cornil and Ranvier, from whom the above account is taken, do not accept this theory.

Fibrin, the immediate factor in coagulation of the blood, does not exist as such in the normal condition of this fluid. Under healthful conditions, the blood would circulate always without any deposit of fibrillated fibrin in the economy. According to Denis, the normal plasma of the blood can be separated into a semisolid substance—*plasmine*, and a liquid—*serine*. Plasmin is further separable into *fibrin* and *metalbumen*, and it is held that the coagulation of the blood is due to the conversion of plasmin into fibrin. This is the theory of Denis. Foster holds that coagulation is the result of the interaction of two bodies, *paraglobulin* and *fibrinogen*, brought about by the agency of a third body, *fibrin-ferment*. A. Schmidt has carried experimentation further, and is led to believe that paraglobulin and fibrin-ferment both originate in the white blood-corpuscles. This theory is exceedingly seductive, and it cannot be denied that actual pathology proves that around and within inflammatory areas where white blood-corpuscles are most abundant, coagulation and fibrillation are more apt to occur, and a study of thrombi which have been gradually formed, reveals alternating layers of white corpuscles and fibrillated fibrine. (Green.)

What may be the principle in the blood which is the factor of coagulation, or what reaction it is which precipitates the fibrin, we cannot in the present condition of science positively assert. The facts, however, "point to the conclusion that when blood is contained in healthy, living bloodvessels, a certain relation or equilibrium exists between the blood and the containing vessels, of such a nature, that, as long as this equilibrium is

maintained, the blood remains fluid, but when this equilibrium is disturbed by events in the blood or bloodvessels (or by the removal of the blood), it undergoes changes which result in coagulation." (Foster.)

So delicate is the sensibility of the blood to mechanical irritation or hindrance in its flow, that the slightest injury or roughening of the endothelial lining membrane may produce a deposit of fibrillated fibrin. A delicate needle, or wire, or thread, thrust into the lumen of a healthy vessel, precipitates coagulation upon the foreign body. The white corpuscles are found clustered in great numbers on the foreign body, and, when the mass is examined with the microscope, the corpuscles seem to serve as starting points for the development of fibrin. (Reichert.)

CAUSES AND CLINICAL HISTORY OF PHLEBITIS.—Phlebitis has been termed traumatic and idiopathic, and the latter term has been applied indiscriminately to all forms of phlebitis not directly due to an appreciable lesion.

Idiopathic phlebitis is comparatively a rare affection (Virchow). It may occur without a traumatism, as from exposure to cold, or as a sequel to fevers and varicosities (Hamilton). It may occur as a complication of syphilis (Hutchinson), or as a result of the gouty diathesis (Paget). From whatever cause it may proceed, idiopathic phlebitis usually affects the veins of the lower extremities.

Traumatic phlebitis may be caused by a partial or complete solution of continuity of the venous walls, by contiguity of inflamed tissues, or by violent muscular action and pressure.

The inflammation of the uterine sinuses during and after parturition, which Cornil and Ranvier style "*la phlébite spontanée*," is really a form of traumatic phlebitis, due to the irritation resulting from pressure and muscular action.

Phlebitis has been described as acute and chronic (Gross); adhesive and suppurative (Bryant); gouty and diffuse (Hamilton). These terms but express varying conditions of one pathological process—*inflammation of a vein*; whether this inflammatory process shall result in adhesion or suppuration, shall become diffused, or shall assume a chronic form, will depend solely upon the character and cause of the disease, and upon the physical power of the patient to resist its progress.

I. IDIOPATHIC PHLEBITIS. (1) *Syphilitic Phlebitis*.—Mr. Hutchinson has called attention to the very few cases of syphilitic phlebitis which have been recorded, and yet he says that most surgeons are familiar with the fact that inflammations around varices, and even about otherwise healthy veins, are not infrequent in syphilitic subjects.¹ Mr. Hutchinson further says, "I think also that I have seen several cases in which the thrombosis and phlebitis were attended by other conditions sufficiently peculiar to justify a belief that they were of specific origin. In some there has been great excess of inflammation, a large hard mass forming in the cellular tissue, and threatening to slough, much as subcutaneous gummata often do. These cases are much benefited by the iodide of potassium, so far as prevention of sloughing is concerned, but the thrombotic plugging remains."²

(2) *Gouty Phlebitis*.—Subjects (says Mr. Bryant) who are gouty from hereditary or acquired causes are liable to phlebitis. Paget has described the affection in his "*Clinical Lectures*," and Mr. Gay has written upon it. In such cases the phlebitis may have no intrinsic characters by which to distinguish it, yet not rarely it has peculiar marks, especially in its symmetry, apparent metastases, and frequent recurrences. Like other forms, it is more common

¹ J. H. C. Simes and J. Wm. White, in Cornil on Syphilis.

² Ibid.

in the lower than in the upper extremities, yet it may be found anywhere. It affects the superficial rather than the deep veins, and often occurs in patches, affecting on one day, for example, a short piece of the saphenous vein, and the next, another portion of the same vein, some other distant vein, or a corresponding piece of the opposite vein.

The inflamed portions of the vein usually feel hard and are painful to the touch. The soft parts covering the vein become slightly thickened, and often have a dusky, reddish tint. When the deep veins are involved, œdema appears, with the well-recognized results of obstruction—the limb becomes big, clumsy, featureless, heavy, and stiff; its skin is cool, and may be pale, but more often has a slightly livid tint, which may be recognized by comparison with the other limb; and it has mottlings from small cutaneous veins, visibly distended. The limb thus enlarged feels œdematous throughout, but firm and tight-skinned, not yielding easily to pressure, and not pitting very deeply.

The constitutional symptoms associated with this affection vary from some slight febrile condition to those met with in acute gout. Complete recovery may take place in this as in other forms of phlebitis, the veins becoming pervious in some cases and obstructed in others. The risks of embolism are also the same. (Bryant.)

(3) *Acute Idiopathic Phlebitis* (not gouty or syphilitic).—This form of venous inflammation—caused, as has been said, by exposure to cold, due to the presence of a varicosity, or coming in the course of a severe febrile attack—may involve one or more veins. The disease travels along the vessels in the direction of the heart. The veins become swollen, and are hard to the touch, resembling the normal veins when the return circulation is momentarily arrested, though more cord-like in feel and less elastic. Their course can be traced by the dull-red color of the skin immediately over the diseased vessels. Pain is generally constant, and is rendered more acute by pressure. The œdema of the parts on the distal side of the lesion is commensurate with the obstruction to the return circulation caused by the inflammatory process. The febrile movement varies with the violence of the attack, the rapidity of its progress, the intensity of the inflammation, and the capacity of the tissues to resist invasion. In the severe forms, the clinical history is similar to that of traumatic phlebitis, which will be fully described hereafter. Idiopathic phlebitis is not as dangerous to life as the traumatic variety. It may run a short course, and the patient recover promptly, or it may assume a subacute or chronic form, and remain indefinitely.

II. TRAUMATIC PHLEBITIS.—When a vein is injured, inflammation will result, if the vessel is penetrated to its cavity, or suffers a solution of continuity. I have even known acute, traumatic phlebitis to result from a prolonged forced flexion of the leg on the thigh, leading to thrombosis and occlusion of the popliteal vein. The simplest form of traumatic phlebitis is that resulting from the operation of venesection. No matter what may be the character of the traumatism, the pathological process is the same. The mode of termination of this process will depend upon the extent and severity of the lesion; and upon the recuperative powers of the tissues involved. Traumatic phlebitis extends from the original lesion along the vessels in the direction of the heart. In the deeper veins it is with difficulty recognized in the earlier stages. The course of the inflammation is marked by a dull, coppery-red staining. Pain is invariably present, and upon pressure is acute. In severe cases the tumefaction spreads from the vessels to the surrounding tissues. Œdema of the parts on the distal side of the lesion will occur in a degree commensurate with the interference with the return circulation. The febrile movement is that of septic fever: chills or rigors, flushes of heat ending in cold and exhausting sweats,

sleeplessness, hectic, anxious expression, and often the "pyæmic breath." The rectal temperature is variable and high; the pulse is thready and rapid, reaching in some instances 160. Sudden and dangerous symptoms may arise in the course of the disease, when particles from the venous thrombi are carried toward the heart. These usually lodge in the lungs, giving rise to sudden pulmonary complications, the result of infarction. The liver, in phlebitis of the veins which go into the portal circulation, is frequently the seat of embolic abscess. Hemorrhage from perforation of the venous wall by ulceration or gangrene, is another source of danger in severe cases of phlebitis.

TREATMENT OF PHLEBITIS.—Positive and complete rest is the first great essential in the treatment of phlebitis. Manipulation or movement is dangerous, since interference will not only exaggerate the inflammatory process, but may possibly cause the separation of thrombi and produce infinite harm in remote organs. If the disease should assume the suppurative form, the inflammation being diffuse and the œdema severe, I should practise free incisions parallel to the veins, secure as free drainage as possible, and employ constant irrigation until the more urgent symptoms had disappeared. I consider quinia to be indicated, not only on account of its well-known tonic and antifebrile properties—although not strictly antiseptic in its action, the bacteria of septic fluids resisting its action to a great extent (Bartholow)—but because it exercises an inhibitory influence upon the emigrant corpuscles (Binz), important factors, as Cohnheim has shown, in the inflammatory process. The use of iron, careful feeding, and a supply of pure air and plenty of it, will complete the constitutional treatment. Locally, the part should be invested with cotton batting, laid upon and not bound to the member affected. The extremity involved should be slightly elevated to favor the return circulation.

ARTERITIS.

Arteritis is a term applied to an inflammatory process which involves the entire thickness of the arterial wall. When the inflammatory change is confined to the inner coat, or intima, it is designated as *endarteritis*; when to the outer coat, or adventitia, as *periarteritis*; and when to the middle coat, or media, as *mesarteritis*.

While arteritis is not an infrequent disease, it is seldom that either of the above subdivisions of this morbid condition exists alone. Endarteritis, if it does not rapidly disappear soon after its inception, will lead in great probability to lesions of the media and adventitia, and in like manner a lesion of the external tunica will in all probability involve, by the extension of the morbid process, the other coats.

There are, however, certain well-defined, circumscribed lesions of the separate tunics. Endarteritis is, as an isolated lesion, capable of demonstration. We shall see that a superficial inflammation of the endothelia, with its resultant fatty degeneration, is not infrequent. Again, mesarteritis exists as a primary and separate inflammation, for primary calcification (denied by some pathologists), which is strictly a disease of the tunica media, precipitates an inflammation in this middle tunic. And since atheroma and other arterial lesions are due to interference with the blood-supply through the vasa vasorum, or to defect in the quality of the blood distributed to the adventitia through which the vessels ramify, we must recognize a periarteritis as the initial stage of this lesion.

Inflammation may be established in any or all parts of the arterial system. One form of arteritis will involve the larger trunks, while another will pass these without molestation, and establish itself in the distant arterioles. Simple endarteritis is most apt to occur in the aorta and arteries of the second magnitude, while syphilitic arteritis, the most marked lesion of which is an endarteritis, rarely attacks the larger trunks, but does its dangerous work in the more or less complete occlusion of the small and smallest arteries.

Inflammation of the bloodvessels, and of the arteries especially, is a process which demands a consideration second in importance to none in the domain of surgery. So protean are the changes it produces, so great the dangers it entails upon tissue life, and so important its early recognition and prompt arrest (if such be possible), that I take the liberty of going beyond the province usually allotted to surgical discussion, and of giving here in condensed form the latest contributions to our knowledge of the histology of the arteries:—

The internal coat of the larger arteries is composed of two parts: (1) An endothelial lining membrane, consisting of a single layer of flat, polygonal, nucleated cells, slightly elongated in the axis of the vessel; in edge view, these cells appear spindle-shaped, on account of the elevation of the nucleus at its centre (Heitzmann); (2) A subendothelial layer of flattened, nucleated, anastomosing cells resting in a fibrillated basement substance, the direction of the fibrillæ being generally parallel with the long axis of the artery (Cornil and Ranvier). In the smaller arteries this layer is exceedingly fine, while in the aorta it is comparatively thick, being composed of two distinct layers. Here the internal of these two layers is longitudinal, the external transverse in direction. The middle coat in the larger arteries, such as the aorta and carotids, is composed of elastic laminæ and of fibres, forming by their anastomoses a continuous system, and holding in the meshes of their loops the muscular tissue, transverse in its direction, and a relatively small amount of connective tissue (Cornil and Ranvier). According to C. Toldt, the muscle-fibres of the middle coat are wanting in the initial portion of the aorta, in the pulmonary artery, and in the arterioles of the retina. In the descending aorta, the common iliac, and the popliteal, small bundles in an oblique or longitudinal direction are interspersed between the circular ones, and in other arteries, such as the renal and spermatic, at the inner boundary of the muscular coat, scanty longitudinal bundles occur, which by some are considered to belong to the inner coat. At times, in the corresponding arteries of different persons, differences are observed in the distribution of the muscles of the middle coat (Heitzmann). On the side nearest the inner coat, the middle tunica is limited by a denser and more defined elastic lamina, which shows, however, on transverse section, a festooned appearance—very important in the study of the pathology of arteritis—and is named the internal layer of the elastic coat. Upon the side of the tunica media nearest the external coat, the elastic fibres pass outward, interlacing freely with the connective tissue of the adventitia. In the femoral, brachial, and other arteries of middle size, the middle coat possesses only one layer, namely, the internal elastic. The muscular fibres are transverse in direction, and form themselves into flattened bundles, separated by connective-tissue bundles and by elastic fibrillæ, which are continuous on the one hand with the inner, elastic layer, and on the other with the elastic network interwoven with the adventitia. There are no vessels in the middle and internal coats. In the external coat are found arteries, capillaries, veins, lymphatics, and nerves.

The small arteries have a middle coat, formed of involuntary muscle-cells, so interwoven that they form a continuous membrane (Cornil and Ranvier).

C. Heitzmann¹ describes this layer as seemingly twined round the artery. The adventitia here is composed of small bundles of connective tissue arranged in the main in a longitudinal direction.

PATHOGENY OF ARTERITIS.—The causes of arteritis are numerous. The most frequently recognized form is that resulting from injury, and known as *traumatic arteritis*. The pathogeny of the *non-traumatic (idiopathic) arteritis* embraces every form of dyscrasia. It follows in the train of syphilis, rheumatism, gout, alcoholism, and nephritis, with great regularity, and may occur as a result of any morbid process which poisons the blood or impairs its nutritive qualities. These varieties will be considered under special headings.

The sequelæ of arteritis, as far as the arteries are concerned, may be fatty infiltration and degeneration, atheroma, secondary calcification, occlusion, dilatation, aneurism, suppuration, ulceration, and rupture. Remotely, partial or complete loss of function of the organs beyond the lesion, and partial or general necrosis or necrobiosis. I shall consider arteritis under two great heads, *traumatic* and *non-traumatic*, subdividing these as their pathogeny or pathology may justify in the consideration of each separate type.

I. TRAUMATIC ARTERITIS.—Arteritis may result from violence, either from without or from within. External violence will produce an inflammation of all the tunics of an artery, in the majority of cases, while violence from within is more apt to cause an endarteritis. *Arteritis from external causes* is never an uncomplicated injury. The perivascular tissue is of necessity involved in the inflammatory process. In the arteritis resulting from deligation of an artery, from the forcible compression of a vessel, as in bending the knee, from the pressure of a tumor, or from a blow in the track of the artery, there is always an accompanying inflammation of the surrounding, injured tissues.

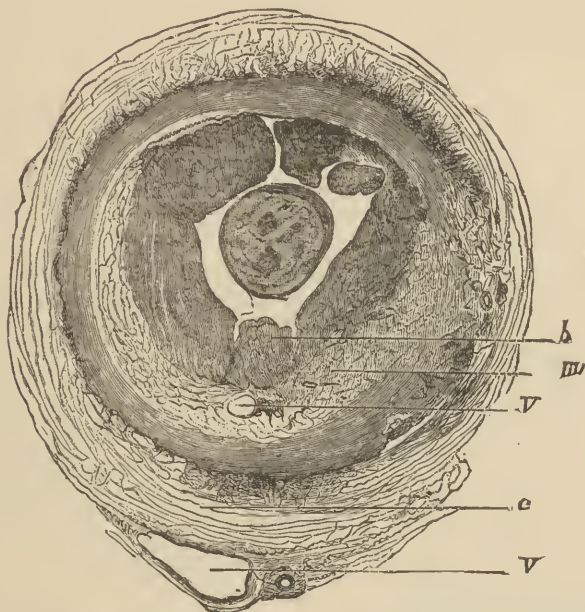
The pathology of traumatic arteritis does not differ greatly from the inflammatory process which occurs in other vascular tissues. Immediately following the injury there is a marked increase in the vascularity of the adventitia. The vasa vasorum become swollen, the white blood-corpuscles crowd into the terminal capillaries, and migrate into the extra-vascular spaces, while a rapid proliferation of the normal cell-elements of the arterial tunics takes place. The connective-tissue cells of the adventitia, the white corpuscles, and the flat and polar cells of the intima, all take part in the morbid process. The walls of the vessel become abnormally thickened, while, owing to the projection inwards of the intima, the calibre of the vessel is diminished. If the intima have been broken or bruised by the injury, the encroachment upon the calibre of the vessel will be more rapid, for in addition to the mass of embryonic tissue pushing into the lumen of the artery, there will be a deposit of fibrin upon the roughened and projecting internal tunic. The white corpuscles in the passing blood-current adhere to the inflamed surface, and undergo a change which causes a liberation of the fibrino-plastic matter which they contain, and a deposit of fibrillated fibrin. This coagulum is found to consist of alternate layers of leucocytes and fibrin. In the mean time, if the inflammation be not so severe that rapid necrosis occurs from the sudden arrest of the blood supply through the vasa vasorum, new-formed capillaries push through the mass of new-formed embryonic cells, into the true "granulation buds" (Fig. 514) which project into the lumen of the vessel.

This form of arteritis may result in permanent occlusion of the vessel (*endarteritis obliterans*), or the function of the artery may be restored. If occlusion occurs, it results from the organization of the embryonic cells into

¹ Microscopical Morphology of the Animal Body in Health and in Disease. New York, 1883.

a new tissue which undergoes fibrillation and contraction, a process of cicatrization, to such an extent that the new-formed capillaries are more or less

Fig. 514.

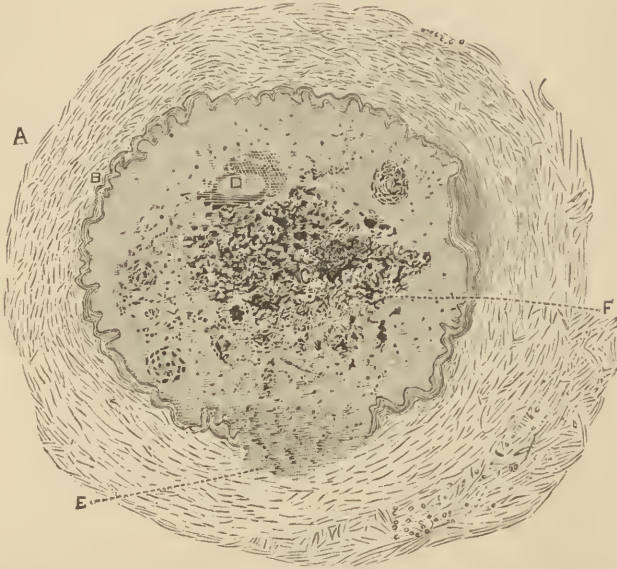


Traumatic arteritis. Transverse section of the carotid artery of a dog, fifteen days after ligature; *b*, granulation buds formed from projection of the intima. In the centre of the figure one of these buds has been completely cut across; *m*, portion of the media modified by the inflammatory process; *e*, adventitia; *VV*, vessels cut across, one of which is newly formed in the intima. Magnified 15 diameters. (After Cornil and Ranvier.)

occluded, and the artery shrinks to become a fibrous cord. (Fig. 515.) Or the coagulum may undergo fatty degeneration and be swept away with the current of blood, the vessel remaining pervious and bearing but little trace of the inflammatory process through which it has passed. The microscopical appearances of a localized traumatic arteritis are typically represented in Fig. 516, which is copied from a section made from the carotid of a horse. The animal was in a healthy condition at the time of the operation. I tied the artery with a broad carbolized ligature, the sciatic nerve of a calf. It was tightly drawn and tied in a double knot. The wound was washed out with five per-cent. carbolic-acid solution, and sewed up. It did not unite by first intention. In the fifth week the animal was killed. The artery was pervious. The location of the ligature was easily recognized by the peculiar, whitish, pearly appearance of the intima at the point of tying, where it was slightly elevated. The adventitia did not show any changes to the naked eye. The ligature had evidently slipped soon after the operation, probably within a few hours. The intima was not broken, but simply bruised within the grasp of the ligature. Active proliferation of the cells of the intima had resulted from this irritation. Not only is the intima seen to bulge into the lumen of the vessel, but the mass of embryonic tissue encroaches outwards upon the media, which is thinner at this point than elsewhere. At one point the media has entirely disappeared, leaving the intima and externa in actual contact. The adventitia has not undergone much change. A few inflammatory corpuscles are found among the connective-tissue bundles. If, after an injury which induces arteritis, the vessel be not occluded throughout the

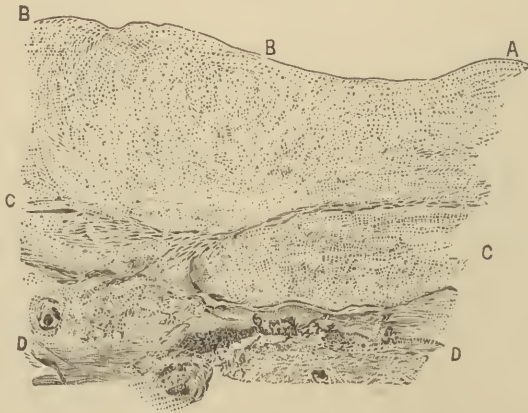
extent of the lesion, and the injury or resulting inflammation be so severe and intense that rapid occlusion of the capillaries in the arterial wall takes place, suppuration and ulceration of the wall occur, with hemorrhage. Or

Fig. 515.



Endarteritis obliterans, not syphilitic. Transverse section of the basilar; A, muscular layer; B, elastic layer. The lumen of the artery is entirely filled with a new formation, which has become canalized by new vessels at *DDF*; c, blood pigment; E, hyaline material, part of the new formation encroaching on the media at E, and seen elsewhere. (Drawn by Dr. W. L. Wardwell, from a specimen borrowed from Professor W. H. Welch. Magnified 60 diameters.)

Fig. 516.



Traumatic endarteritis. Section from the common carotid of a horse, tied with a broad nerve-ligature, showing at *BB* the proliferation of the intima. The inflammatory new formation is projected into the lumen of the vessel, and has caused partial atrophy of the media, *c*; A B, the intima; B B, portion of the intima in the grasp of the ligature; *D*, the adventitia, slightly changed, with small-cell infiltration. (Drawn by Dr. W. L. Wardwell, from the author's specimen. Magnified about 40 diameters.)

septic matter may pass into the vessel from the surrounding, inflamed tissue, and lead to infarction and pyæmia. The same condition may result from

an extension of inflammation from the surrounding tissues into the arterial wall, as in phagedæna.

Treatment.—No unvarying plan of treatment can be laid out for traumatic arteritis. The circumstances of each case must be separately considered. To prevent gangrene, and to guard against hemorrhage, are the indications most to be regarded. Rest, position, quiet, and careful nutrition, are the most important points of treatment.

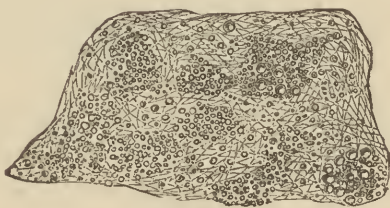
Traumatic arteritis resulting from *causes within the vessels* usually begins as an endarteritis. It may never involve any other tunic than the intima. Many cases of acute traumatic endarteritis are described as idiopathic inflammations. They are none the less due to violence—to the impinging force of the blood-current—for this lesion occurs at those points in the arterial system where the pressure is greatest. Endarteritis and the fatty degeneration resulting from it (Figs. 517, 518) are most frequently seen in the sinus magnus of the aorta, in the transverse segment of the arch of the aorta, at the aortic bifurcation into the two common iliaes, and in the arch of the innominate. The arteries of athletes, which are subjected to prolonged distention resulting from violent muscular exercise, are prone to suffer from this disease.

Fig. 517.



Arteritis with fatty degeneration. Showing fatty degeneration of the intima of the aorta. The nuclei of the normal cells are represented by the larger bodies, one of which is seen at *m*; the smaller bodies, as at *g*, are fatty granules. Magnified 400 diameters. (From Cornil and Ranvier.)

Fig. 518.



A form of fatty degeneration after arteritis. Fatty degeneration of the internal coat of the aorta. Minute yellowish-white patches scattered over the lining membrane of the vessel. A very thin layer peeled off and magnified 200 diameters, showing fat molecules and the distribution of fat in the intima. (From Green.)

Vegetations from the heart may produce endarteritis when they are extensive enough to pass through the aortic valves. Fragments from whatever source, carried along the vessels, produce arteritis at the point of lodgment.

If we examine the intima of an artery which has been the seat of recent endarteritis, it will be seen to be swollen, and thicker and softer than in healthy vessels. The swelling is not usually general and continuous, but occurs in patches or hillocks of quite regular contour, which project into the lumen of the vessel. The intima is usually injected, and reddish in color, though, according to Cornil and Ranvier, when the inflammation has been of a very severe type, the swollen intima is paler than normal. If the inflammation be of recent origin, these patches will present an unbroken surface, but if softening has occurred, the centres of the elevations break down, resulting in erosions or ulcers as they have been styled by some pathologists. Green says that they are due to softening of the intercellular substance, and that the cells and granular matter, becoming loose from this softening, are washed out

by the blood-current. These erosions resemble considerably the superficial erosions found often in the mucous membrane of the stomach. At times they are covered over with a layer of fibrin, which, upon close inspection, is found to be composed of one or more laminae of fibrillated fibrin, with corpuscular elements entangled in or resting between them.

Beneath the projecting intima is found a mass of inflammation tissue, consisting of embryonic and large anastomosing cells resembling the normal connective-tissue cells of the most external structure of the intima. Hyperplasia of the normal cell-elements is more marked as we approach the inner layers of cells of which the intima is composed, the proliferation growing gradually less extensive as the elastic lamina is neared. This condition is a feature of acute endarteritis, and differs both from the inflammation of the atheromatous process and from syphilitic endarteritis.

This mass of new-formed embryonic tissue is, in all probability, the immediate result of proliferation of the normal cell-elements of the intima. Emigrant corpuscles could only reach this location by traversing the media, for as yet the capillaries have not been projected into the inner tunic. Nor is it probable that leucocytes from the blood-current within the artery involved, migrate through the endothelia into the proliferating mass.

The adventitia does not long remain undisturbed by the pathological changes which have occurred in the intima. It takes on an inflammatory process in a varying degree, and this tunic is found thickened from the proliferation of its connective-tissue cells. If the process be obstinate and persistent, a true arteritis is developed, and all the pathological conditions which have been described on a previous page, may be present.

The media is not greatly altered in the early stages of endarteritis or periarteritis, though in calcification it is apt to be first attacked, as it is likewise in fatty infiltration and degeneration.

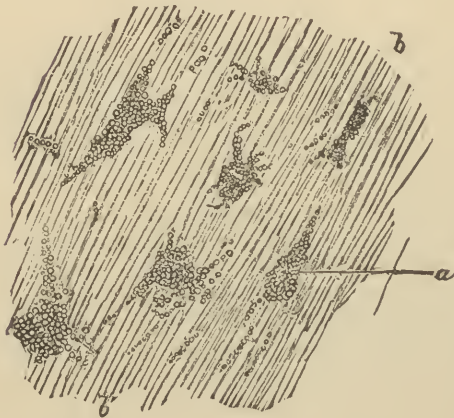
Acute endarteritis may terminate in recovery, leaving no permanent trace of its having existed, or it may pass into a chronic inflammation, which usually ends in fatty degeneration.

This degeneration begins in the endarteritis proper, and travels towards the media. The appearances of an artery which has undergone this change are well shown in Fig. 519.

Fatty degeneration, in its microscopic appearances, resembles very much the atheroma which is, at times, found in the intima. It can, however, by gentle and careful scraping, be removed, revealing the more or less normal tissues underneath, while in advanced atheroma, which involves the deeper structures first, no trace of the normal tissues can be discovered.

Chronic arteritis may follow an acute endarteritis, as has been indicated above, although the chronic arterial lesions, as a rule, begin with periarteritis or mesarteritis.

Fig. 519.

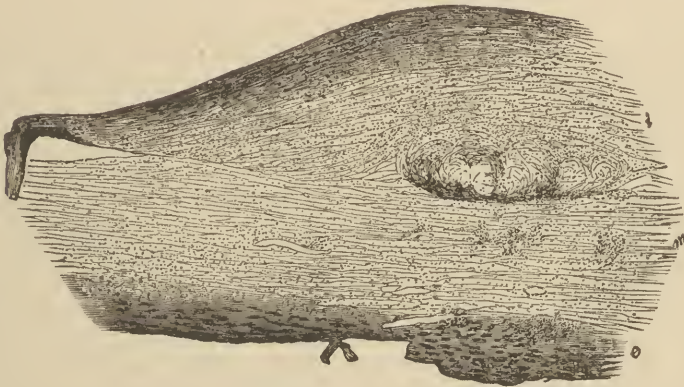


Arteritis with fatty degeneration. Fatty degeneration of the internal coat of the arteries from a thin layer stripped from this membrane. *a*, Fat granules in irregular patches over the surface. The granules have resulted from fatty degeneration of the cells of the intima. *b*, Fibrillated tissue. Magnified 200 diameters. (Cornil and Ranvier.)

II. NON-TRAUMATIC OR IDIOPATHIC ARTERITIS.—The inflammatory process in idiopathic arteritis differs only in degree from that heretofore described as occurring in traumatic arteritis. When not due to syphilis, gout, rheumatism, nephritis, or some dyscrasia, it is usually a part of an inflammation of the tissues immediately surrounding an artery. The process commences in the adventitia, and is analogous to that of traumatic arteritis.

ATHEROMA AND CALCIFICATION.—One of the frequent and most serious terminations of chronic arteritis, no matter what may have produced the arterial lesion, is the condition known as atheromatous degeneration (Fig. 520). It

Fig. 520.



Atheroma following arteritis. Section of aorta undergoing the atheromatous change, showing the cellular infiltration of the deeper layers of the inner coat, and consequent bulging inwards of the intima. The new tissue has undergone more or less fatty degeneration. There is some cellular infiltration of the middle coat. *i*, the internal; *m*, the middle; *e*, the external tunic. Magnified 50 diameters and reduced one-half. (Green.)

is essentially a disease of mal-nutrition. It is a senile change, not of necessity coexistent with another disease. It is, as will be proven hereafter, prone to attack the arteries, especially those of the brain, in syphilis, and the larger arteries in other affections. The fatty degeneration of endarteritis is a primary lesion, that of chronic arteritis is secondary. The one is local, the other general. Recovery from the one is possible, and the danger of death is slight. Shreds of fatty material may be carried by the blood and lodged in the cerebral or other remote vessels, doing great injury; but this accident is rare. The possibilities of chronic arteritis with atheroma are always grave. Above the dangers of thrombosis and embolism, and of calcification, are those of aneurism and of hemorrhage. The early recognition of this condition, though exceedingly difficult, is no less important. Atheroma commences in the deeper tissues of the arterial wall, and, advancing in the line of blood-supply, taps the sources of nutrition of the deeper tunics, causing their loss of function, death, and disappearance. It is a true necrobiosis.

The fatty degeneration of atheroma not only involves the innermost layer of the intima (as does that form of degeneration which follows endarteritis), but the muscular-fibre cells undergo complete metamorphosis, while the elastic lamina is the seat of extensive infiltration. In severe cases the work of destruction is complete, the normal tissues disappearing, and leaving nothing but a granular débris.

Atheroma does not usually destroy an extensive area of the intima. The patches may be numerous, but not large. The molecular disintegration is

confined to certain well-defined spots, in the centre of which is found the softened, broken-down "pulp" which has given rise to the term "atheroma." Examined under the microscope, the contents of these pulp-cavities will be found to consist of fat granules, granular corpuscles, and cholesterin crystals, exactly analogous to those sometimes found in abscesses of long duration. Shreds of fibrous tissue may be present. It can be readily conceived how the rupture of one or more of these pulp-cavities, together with the weakened state of the middle and outer coats, would lead to the formation of aneurism. This danger is not so imminent when the inflammatory process has advanced slowly, for the reason that secondary calcification (a conservative process) is more apt to take place. The same may be said of primary calcification where the lime salts are deposited in the "coagulation necrosis" of the media.

The atheromatous and calcareous degenerations may exist in the same location and at the same time. While the cell-structure of the intima is being transformed into granular matter, the fibrillated basement substance nearest the media is the seat of calcareous deposit, at first granular, the granules adhering to form clusters or flakes. At the same time, the nuclei of the muscular-fibre cells are filled in and around with calcareous matter. The entire muscular coat may be converted into a calcified cylinder, or, as is most usual, the process may be confined to isolated patches. In either case, the entire thickness of the wall may eventually undergo the same morbid changes.

When the layer of cells between the calcareous deposits and the blood-current has been broken down by the atheromatous process, it may disappear in the blood and leave the flakes of calcareous matter exposed to view from within. These in turn may be carried away, or they may be undermined by the blood-current and lead to aneurismal pouches by dissection. With atheroma, calcareous degeneration may invade the entire arterial system, the arteries of the extremities becoming brittle and unyielding. The smaller arteries are most apt to be involved, especially those of the brain. This condition is a part of senile malnutrition, and leads to more or less complete occlusion of the vessels, to loss of function of the portions of the body most seriously involved, and to gangrene. It is the commencement of death.

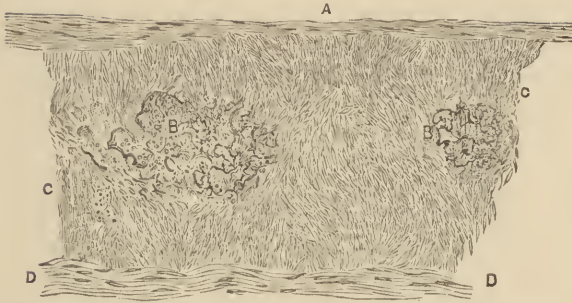
In many cases of atheromatous and calcareous degeneration in the aged, enormous dilatations occur. The dilatation is not uniform, as a rule, but the walls of the dilated artery (usually the aorta and the arteries of the second class) are pouched in many places. The calcareous matter will be found to be thickest in those portions of the wall which are less dilated, while the dilated pouches have undergone a more complete fatty degeneration. This condition is commonly known as *arteritis deformans*.

The middle coat may be in places entirely destroyed, when the changed intima will be joined with the adventitia by a connective tissue new-formation, which (see Fig. 514) contains vessels passing directly to the intima. Loss of the elastic tunic is one of the immediate causes of spontaneous aneurism (Cornil and Ranvier).

This condition of atrophy of the elastic lamina is beautifully shown in Fig. 521, which was drawn from one of my specimens by Dr. Wardwell.

Calcification of arteries has been especially studied by Dr. W. L. Wardwell, of New York City, in Cohnheim's Laboratory. His experience includes examinations made from twenty-five cases at the request of Cohnheim, who assents to his conclusions. Dr. Wardwell says all authorities recognize a morbid change in the arteries known as calcification, and the majority look upon it as a change secondary to atheroma or endarteritis. Few of these recognize a primary calcification not dependent upon a preceding inflammation. This condition is, however, the chief change in the senile calcification

Fig. 521.

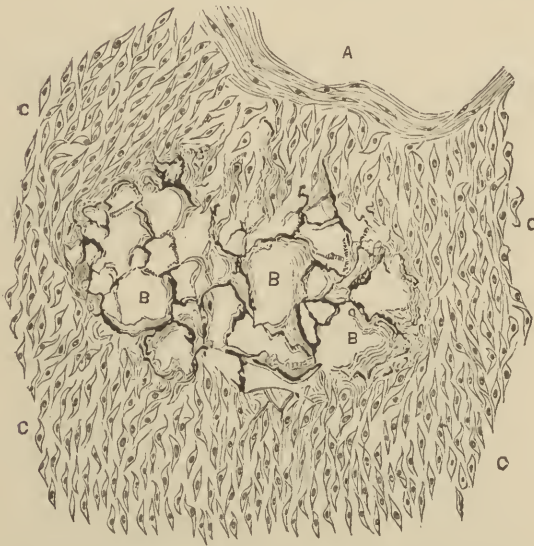


Showing calcareous degeneration of the media. A, intima; C C, media; D, adventitia; B B, calcareous patches. Ulnar artery. Magnified about 60 diameters. (From a specimen prepared by Dr. W. L. Wardwell.)

of arteries. The microscopic appearances of primary calcification are well shown in Fig. 522.

Cohnheim states that in senile arterial calcification, sometimes the media, sometimes the intima (its outermost layer), is affected, and that in them the lime salts are deposited. Moreover, that this deposit of lime takes place here because these tunics have been subjected to the greatest strain.

Fig. 522.



Arteritis with primary calcification. Section from human radial artery, showing at B, primary calcification of the media C. A, the intima comparatively unchanged. (Drawn from specimens prepared by Dr. W. L. Wardwell at Cohnheim's Laboratory. Magnified about 350 diameters.)

Weigert¹ describes a "hitherto undescribed" process known as *coagulation necrosis*. Beginning with the theory of Schmidt concerning the coagulation of the blood, in which the white corpuscles play the leading part, he argues that all tissues have the power of spontaneously coagulating, it being necessary for such an occurrence that the cells should die, give up their ferment and

¹ Virchow's Archiv, Bd. lxxix. S. 87.

fibrino-plastic material, and then become saturated with a fibrinogen-holding lymph. This morbid process he holds may occur in tissues the most diverse in character, as in cheesy glands, infarcts of the spleen or kidneys, tumors, the inflammatory material around parasites, tubercle, etc. Macroscopically, these coagulated spots have a peculiar, stiff appearance, and, microscopically, they are recognized by the fact that the cell nuclei have disappeared, and cannot be made to appear by reagents or by the coloring material used in the microscopical technique.

Weigert states further that to this process belongs a hitherto undescribed tissue-necrosis, viz., the so-called atheromatous degeneration of the aorta and the syphilitic disease of the arteries. There are found in the walls of the vessels many spots with no nuclei, often too small to allow any one to reach a positive conclusion in regard to them. Often, however, these spots are larger and present a fibrinous appearance. These are found not only in the newly formed tissue, but elsewhere, and Weigert attributes to them the chief cause of the inflammatory and hyperplastic tissue-changes which are peculiar to the atheromatous and sclerotic processes; he also declares that the tissues in these spots tend to calcareous degeneration.

Dr. Wardwell arrives at the following conclusions:—

(1) That in the arteries of middle-aged or old persons, there are often found spots of diseased tissue which present all the appearances of having undergone a "*coagulation necrosis*."

(2) That in these spots there is a tendency to the deposition of lime salts.

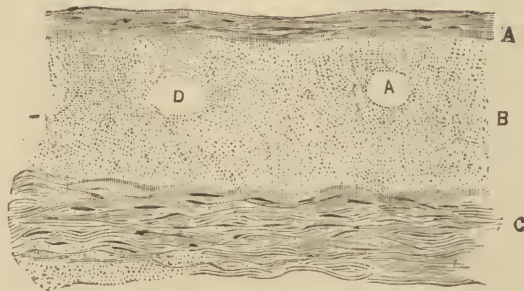
(3) That in primary calcification the media is always first affected, the intima and adventitia only secondarily and by contiguity.

(4) That this change is independent of a preceding inflammation.

(5) That on the contrary these calcified spots act as foreign bodies, setting up a secondary inflammation in their vicinity, and leading sometimes to thickening of the intima.

(6) That one of the changes in atheroma of the arteries is coagulation necrosis, that lime salts are often deposited in such necrotic spots, that the position of such spots is in the intima instead of the media, viz., in the newly formed inflammatory tissue.

Fig. 523.

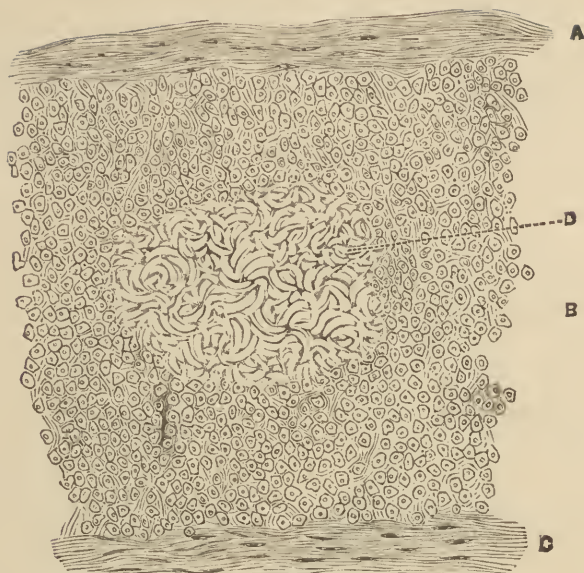


Arteritis with coagulation necrosis. Section from human artery treated with acetic acid, showing at D D, spots of coagulation necrosis which contained calcareous salts before being treated with the acid; A, intima; B, media; C, adventitia. (Drawn from specimen prepared by Dr. W. L. Wardwell. Magnified about 40 diameters.)

(7) That primary calcification attacks the small arteries rather than the larger, and especially those portions of the arteries which are subjected to the greatest strain.

These conditions are shown in Figs. 523, 524.

Fig. 524.



Posterior tibial artery. Section showing coagulation necrosis. A, intima; B, media; C, adventitia; D, spot of coagulation necrosis. Magnified 360 diameters. (From a specimen prepared by Dr. W. L. Wardwell.)

SYPHILITIC ARTERITIS.—Arteritis is a part of the pathology of syphilis. The first danger to life in this disease comes from the changes in the capacity of the arteries. No part of the arterial system is exempt, though the most serious lesions are found in the vessels of the brain, and next in the aorta. They become grave in the larger trunks on account of the atheroma resulting from the syphilitic poison (inducing aneurism), and in the smaller arteries (especially those of the brain) from occlusion or atheroma.

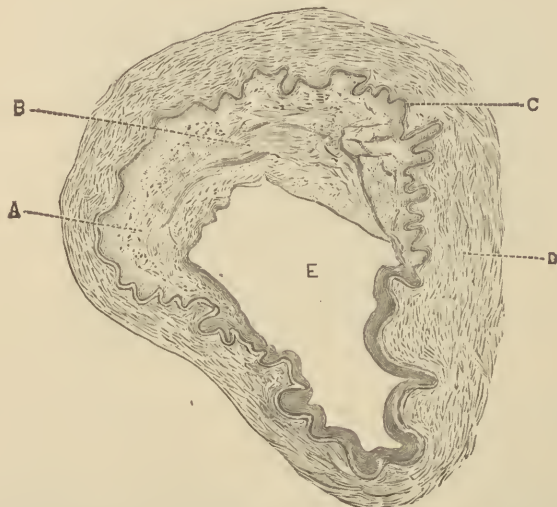
Even in the initial lesion of syphilis (the chancre), according to Biesiadecki, the capillaries of the papillæ have in their thickened walls many nuclei, some of which are seen to project into the lumen of the vessel.

The arteries of the base of the brain, especially the basilar and those at the commencement of the fissure of Sylvius, are often seriously involved. I have seen two cases in private practice in which death resulted from anæmia of the medulla, due to a more or less complete thrombosis of the basilar artery. A patient of Dr. Weber's, to whom I was called, died in my presence. A few days previous to his death he had complained of dizziness, and of a sensation as of insects crawling over the integument of the extremities. Death was quite sudden, and was due to respiratory failure. He became quickly unconscious, and appeared to have lost all sense of the *besoin de respirer*. The respiratory movements were irregular, and co-ordination of movement between the expiratory and inspiratory muscles was seemingly lost. The mode of death was different from anything I had ever witnessed up to that date or have since. At the autopsy, the basilar, just where it divided into the two posterior cerebrals, was found almost completely occluded by a thrombus. There was no other lesion which could have accounted for death. Syphilis had existed for several years.

In the second case, syphilis had existed for nineteen years, with right hemiplegia for the last sixteen years of life. This patient was under my care for nearly five years. She would never consent to take the iodides or any medicine. She was excessively obstinate; her mind was clear up to the time

I last saw her before death, which occurred suddenly one night. I did not see her until life was extinct, but from the description of the mode of death given me by Dr. F. J. Ives, who was present, I was led to express the belief that a similar condition existed as in the case first referred to. On examination, I found a thrombosis of the basilar artery in exactly the same location. Fig. 525 represents a section of the artery near the thrombus. The lumen of

Fig. 525.



Syphilitic arteritis. Section of basilar; E, lumen of vessel about two-thirds filled with new formation at A B; C, media; D, muscular layer and adventitia. From a patient dead from syphilis. (Specimen of the author's, drawn by Dr. Wardwell. Magnified about 40 diameters.)

the vessel is seen to be about two-thirds occluded. The adventitia is slightly thickened, and the cell elements in it are distinctly fusiform, and regularly parallel with each other and with the contour of the adventitia. The wavy elastic layer is easily recognized, and in that portion of the artery in which the syphilitic inflammatory material is deposited, the waves of the media are more numerous and shorter than in other portions of the vessel. In the centre of the mass, occupying a portion of the calibre of the artery, is found a hyaline-looking spot which takes the carmine stain more readily than the general mass of the thrombus. It contains embryonic cells in about the same quantity as the surrounding tissue. The adventitia is not regularly thickened, being three or four times as deep in some portions as in others, and presenting in the section a nodulated appearance. Viewed with a magnifying power of about five hundred diameters, that portion of the arterial wall external to the wavy line (the elastic layer) seen in Fig. 525 presents the following appearance:—

In the most external limit of the section of the adventitia, there are found clusters of inflammatory corpuscles, true embryonic cells, round, and larger than the cells found in any other portion of the specimen external to the elastic lamina. These cells are somewhat smaller in size than those found in the new-formed tissue of the intima, though they differ in shape, since those in the intima appear both round and fusiform, while the cells in the outer edge of the externa appear almost invariably round. It may be possible that they are fusiform cells cut transversely in the section, though after careful examination I am led to conclude that they are round. At various points these cells do not exist, the external layer being that of fusiform cells

arranged with great regularity parallel to the contour of the wall of the artery. Where the wall of the vessel external to the elastic lamina is thickest, these spindle cells are more numerous and have a greater transverse diameter than at the narrower portions, where they seem to have elongated and become thinner—seemingly a true process of fibrillation and contraction of embryonic (inflammatory) cells.

Continuing the examination further inwards, as the white, wavy, elastic zone is crossed, just within and almost in exact apposition with this is a somewhat irregular and thin layer of cells, fusiform in section, varying in depth from a single row to two or three rows, and in some points entirely absent. These are doubtless a remnant of the original endothelia of the intima; just internal to these, and in fact continuous with them, is the great mass of new-formed, inflammatory tissue which juts into the lumen of the vessel. This mass is composed of large, mostly fusiform, cells, distinctly nucleated and occupying about as much space as the intercellular substance in which they are imbedded. (The space seen in some portions of the section between the wavy elastic line and the cell mass in the lumen of the vessel is due to cleavage or splitting off in making the section.) The following conclusions I have arrived at from the study of this case:—

(1) The elastic tunic is very slightly if at all changed by the inflammatory process in syphilitic arteritis. If there be any change, it is due to a corrugation or wrinkling of this tunic in the process of contraction.

(2) The external coat is irregularly thickened, and appears nodular on transverse and longitudinal section. This thickening is the result of the syphilitic inflammatory process, and the external layers of inflammatory corpuscles differ from those (and the greater portion) which form the bulk of the changed external tunic.

(3) The chief lesion in syphilitic arteritis is situated in the intima, and is due in the main to active proliferation of the normal cells of this tunic.

Syphilitic arteritis has been made the subject of special study by Cornil, Heubner, Greenfield, Barlow, Buzzard, Davidson, Simes, White, and others.

Greenfield, in the Transactions of the London Pathological Society for 1877, gives an analysis of twenty-two cases of visceral syphilis. His cases and report are so instructive, and give evidence of such careful study of this important subject, that I quote them almost in full.

Of the 22 patients, 13 were females, 9 males. Their ages varied from twenty-three to fifty years. Of the females, four were between the ages of 23 and 25, one was 35, one 38, the remainder between 40 and 50. Of the males, four were between 30 and 40, the rest between 40 and 50.

These patients did not all die from syphilis, some perishing from other and concomitant diseases. Of those who died from the effects of syphilis, the greater number were comparatively young. Of the four females under 25 years of age, two died from the effects of thrombosis of the cerebral arteries, one from syphilitic disease of the larynx, and one from accident. Of the six males under 40, one died from syphilitic disease of the cerebral arteries, one from gummata of the brain and dura mater, one from pneumonia due to syphilitic disease of the larynx and trachea, one from renal disease consequent upon stricture, and another by accident.

The following table from this close observer is so interesting in the demonstration which it gives of the frequency of arterial lesions in the later stages of syphilitic disease, that I copy it entire.

CASES OF VISCERAL SYPHILIS OBSERVED IN POST-MORTEM ROOM OF ST. THOMAS'S
HOSPITAL DURING THE YEARS 1875-6.

No.	Sex.	Age.	Occupation.	Date of infection.	Cause of death.	Organs affected by syphilis and nature of affection.	Lardaceous degeneration.	Kidneys.	Arteries.	Skin.	Remarks.
1	F.	47	Married	.....	Peritonitis following colotomy for relief of syphilitic stricture of rectum.	Rectum, extensive ulceration and thickening. Liver, some small punctured cicatrices.	None.	Nil.	Nil.	Not noted.	
2	M.	42	Blacksmith	.....	Acute pneumonia secondary to renal disease.	.....	None of liver or spleen; adv'd in kidneys, intestines not noted.	Advanced lardaceous degeneration.	Slight atheroma of aorta and of cerebral arteries.	Rupial eruption and scars of same.	
3	F.	36	Married	.....	Slight phthisis; pleurisy and pneumonia; thrombosis of pulmonary artery.	Ulceration of rectum and vagina; small gummatous tumor in corpus striatum.					
4	M.	38	Carpenter	.....	Broncho-pneumonia.	Extensive disease of palate, necrosis of cricoid cartilage and nearly all the rings of trachea; perihepatitis.	Very slight of kidneys only.	Slight lardaceous degeneration.	Not noted.	Not noted.	
5	F.	26	Married	.....	Thrombosis of cerebral arteries.	Extensive necrosis of nasal and upper jaw bones; gummata in liver, spleen, and kidneys; thickening of middle cerebral artery.	None of liver or spleen.	Gummata and infarcts from arterial obstruction.	Atheroma of aorta; cerebral artery with syphilitic thickening.	Nothing to be discovered on careful examination.	Path. Trans., vol. xxvii. p. 311.
6	M.	34	Sawyer	.....	Meningitis, and gummata in brain.	Osteo-sclerosis of skull, gummata in dura mater, gummata in brain; disease of cerebral arteries.	None.	Congested.	Slight atheroma at origin of aorta, none elsewhere; cerebral.	Not affected.	Case 1 of disease of cerebral arteries, gummata in brain and dura mater shown. Mitral and tricuspid stenosis, see Path. Trans., vol. xxvii. p. 113. Specimen shown.
7	F.	43	Married	.....	Thrombosis of cerebral arteries.	Cicatrices in liver; disease of cerebral arteries.	None.	.....	Cerebral.	.....
8	F.	48	Married	.....	Obstruction of left internal carotid and middle cerebral arteries by clot (? thrombosis or embolism).	Gumma in wall of heart; gummata and cicatrices in liver; gummata in spleen.	None.	Degeneration.	Atheroma of aorta with very prominent patches; middle cerebral (? nature of affection).	Not affected.	
9	M.	43	Carman	24 years	Meningitis from perforation of dura mater by gumma growing in occipital bone.	Very extensive disease of liver per-hepatitis, cicatrices, and gummata larynx, necrosis of cricoid bones. peculiar affection of ends of long bones.	None of kidneys.	Congested.	Not noted.		
10	F.	24	Married	Probably short, in secondary stage	Mitral stenosis; softening of brain ? from vascular disease.	Secondary ulcerations of tonsils and fauces; minute gummata in dura mater.	None.	.....	? Disease of cerebral arteries.		
11	F.	50	House-keeper	.....	Diffuse abscess of thigh, pyæmia.	Gumma in liver: old scars on tonsils.	None.	.....	Atheroma of aorta; external atheroma of cerebral vessels.	Nil.	
12	M.	47	Cutler	.....	Gangrenous ulceration of bronchi, and gangrenous pneumonia.	Ulceration of fauces, tonsils, pharynx, larynx and trachea; necrosis of cricoid and part of thyroid cartilages.	None.	.....	.....	Rupial scars.	

No.	Sex.	Age.	Occupation.	Date of infection.	Cause of death.	Organs affected by syphilis, and nature of affection.	Lardaceous degeneration.	Kidneys.	Arteries.	Skin.	Remarks.
13	M.	40	Soldier	.....	Opium poisoning.	Pnckered cicatrices in lower lobe of right lung; healed gumma in spleen, great enlargement and induration of glands in left groin.	None.	Large (20 oz.); greatly congested	Extreme atheroma of aorta; large, prominent, gelatinous patches.	Large irregular scar on thigh; nature uncertain	
14	F.	35	Servant (unmarried but had had child).	.....	Renal dropsy.	Enlarged and indurated glands in right groin; old disease of pharynx with cicatricial contraction, large mass of gummata and cicatricial fibrous tissue in liver.	Advanced of whole gastro-intestinal and vaginal membranes & of kidn'ys	Lardaceous and fatty.	Patches of endarteritis deformans in abdominal aorta; none of thoracic.	No scars or nodes.	Liver shown.
15	M.	46	Plasterer	.....	Dilated heart; dropsy.	Cicatrices in liver; advanced affection of skin.	None.	.....	Slight atheroma of aorta.	Rupial ulcers on legs; condition of scrotum resembling elephantiasis.	Nil.
16	F.	23	Single, but had one child	3 to 4 years	Asphyxia from removal of tracheotomy tube.	Larynx, extensive infiltration of tissues, abscess over thyroid cartilage.	None.	Congested.	General atheroma of aorta.	Nil.	Lived with a man who had a skin eruption, and the child had an eruption when a few weeks old.
17	F.	46	Widow	.....	Hæmoptysis in rapid phthisis.	Cicatrices and gumma in liver; lungs?	None.	Slightly granular.	Atheroma of aorta.	Nil.	
18	F.	47	Servant	.....	.....	Atrophy of right lobe of liver from perihepatitis and gummatous infiltration.	Of kidn'ys, spleen, and intestines.	Lardaceous degeneration.			
19	F.	25	Unmarried, but cohabiting, and had one child	.....	Fracture of cervical spine.	Syphilitic ulcers of legs; cicatrices in lungs; calcified nodules; probably gummata in liver.	None.	.....	Atheroma.	Nil.	
20	M.	30	Sailor	.....	Cystitis and pyelonephritis from stricture of urethra.	Cicatrices in liver.	None.				
21	M.	34	Plate layer	.....	Thrombosis of cerebral arteries.	Extreme disease of cerebral arteries; dura mater; larynx.	None.	.....	Marked atheroma.	Nil.	Case 2 of disease of cerebral artery; vessels, dura mater, and larynx shown.
22	F.	50	Servant (single)	.....	Hemiplegia due to softening of brain from thrombosis; cystitis, pyelonephritis, and peritonitis.	Extensive but irregular thickening of cerebral arteries; pnckered cicatrices in lower lobe of right lung only, without pleural adhesions.	None.	Right, with multiple suppurative nephritis (surgical kidney); left, normal, no disease either acute or chronic; not lardaceous.	Aorta somewhat atheromatous, not advanced; carotids also atheromatous.	Large, irregular, much pigmented scars on left thigh and legs of old syphilitic ulcers.	

It will be observed that of the total of 22 cases, the condition of the vascular system is noted in all but 6. In one case there was no lesion of the arteries. In the remaining 15 cases the arteries were more or less seriously

involved. In other words, out of 16 cases in which the condition of the arteries was noted, in 15 these vessels were diseased.

The author says that the condition of the aorta and large vessels as regards atheroma is of importance in connection with the dependence of aneurism upon syphilis, and that as regards the smaller vessels, the nature of the disease of the cerebral arteries is of the greatest interest. In the cases heretofore noted in the table, where the kidneys were diseased, the effect of syphilis in producing the atheroma might be questioned. In three females (cases 5, 16, and 19), aged 23, 25, and 25, there was marked atheroma of the aorta. In one, the atheroma was general in the aorta and its larger branches, the condition being that of diffused, irregular swelling, with but little fatty degeneration. The kidneys in this case were structurally healthy. In one female, aged 25, in the first part of the arch of the aorta were several patches, rounded, prominent in the centre, and thicker than usual. On section these appeared homogeneous, and presented scarcely any fatty degeneration. Throughout the rest of the aorta there was general atheroma with no peculiar characters. In another female, aged 35, there were large patches of endarteritis deformans in the abdominal aorta. In this case there was lardaceous degeneration of the kidneys.

In several other cases there was marked atheroma, and in most cases where there was no renal disease the patches were much raised, sometimes almost hemispherical, at other times with sharply defined edges of gelatinous appearance and pearly lustre; and on section there was but little fatty degeneration or calcification.

Whether in these cases the disease would have gone on to the formation of aneurism, cannot of course be decided; but it is evident that a marked tendency to the occurrence of endarteritis deformans at an early age, and in an advanced degree, exists in visceral syphilis. This is especially noticed upon comparing the condition, in these cases, with that in a large number of other patients of the same age who have died from all forms of disease, when it is found that in no others was any atheroma observed apart from the coexistence of very marked renal disease. It is probable that the absence of cases of aneurism from this series is purely accidental, for in a number of other cases Dr. Greenfield has found very marked syphilitic visceral disease in cases of aneurism occurring at an early age.

The cerebral arteries were very markedly affected with syphilitic disease in five cases, and in a sixth were probably diseased.

As to the pathological changes which syphilitic arteritis causes, they are given by Dr. Greenfield in two cases of disease of the cerebral arteries.

The specimens were taken from the middle cerebral and basilar arteries. They are typical and probably represent two different stages of the process. "In the first case the disease is seen in the earlier form, in which it consists almost entirely of a cell-growth which has as yet undergone but little organization. In the second case considerable changes have occurred, and a large part of the new growth is converted into more or less fully developed connective tissue. In the specimen sketched in Fig. 526, the artery is seen to be somewhat irregular in shape, this being due to obliquity of the section. The lumen (*a*) is very small, but is clearly defined, rounded, and free from thrombus.

The outer coat appears somewhat thickened, and is infiltrated in continuity with the pia mater (*f*). The muscular coat (*d*) is distinctly seen at the upper and lower parts of the section, elsewhere being somewhat infiltrated, and not clearly separated from the adventitia. The fenestrated membrane is clearly seen at *b*, where it is indicated by the dark lines; it could be clearly traced on altering the focus, all around the vessel, lying as usual immediately internal

to the muscular layers, and separating them from the inner coat. It is to that part of the vessel lying between *a* and *b* (Fig. 526) that attention must be specially directed, the thickened inner coat constituting the essential feature and the peculiarly characteristic element of the morbid change. With a higher power, the thickening of the inner coat is seen to consist entirely of a cell-growth which closely resembles granulation tissue. In the deeper parts, nearest the fenestrated membrane, the cells appear to be flattened, running parallel with the elastic layer, growing, however, more irregular in disposition towards the centre. No distinct transition line can be discovered between this deeper layer and the central part, in which, however, the cells appear to be larger, often branching and more loosely arranged, with more numerous capillaries running amongst them. Many of the cells in the intermediate layer appear to be rounded, but it is not improbable that they are fusiform cells cut transversely. In many parts of the thickened intima the capillaries are numerous and of large size.

Toward the lumen of the vessel the cells again assume a flattened or fusiform shape, and several layers of these cells closely packed together form the innermost part of the new growth, the most internal, superficial layer (that in immediate contact with the blood-current) forming a continuous layer, which corresponds in its functions to normal endothelium.

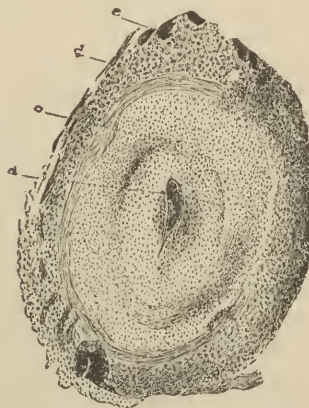
The other specimen (Fig. 527) appears to have undergone different changes. The coats of the vessel are enormously thickened, and the lumen of the vessel correspondingly diminished, so as to become a narrow chink (the section is somewhat obliquely made). The thickening of the wall is found to present great variations, at points of the vessel not further apart than one-twelfth of an inch, other sections at that distance from the one represented in the cut not being more than one-half as thick, the external diameter of the vessel remaining almost constant. The adventitia (*e*) is slightly thickened and infiltrated by a cell-growth. The muscular coat (*d*) is of pretty uniform thickness, except at some points where invaded with cell-infiltration from the adventitia. The inner coat is enormously thickened, and presents the appearance of two concentric rings, the boundary between which is more or less defined. Examined with a higher power (Fig. 528), the lumen of the vessel is found free from thrombus. The membrana fenestrata is well defined. The muscular layer presents very much its normal appearance at some points, except that the fibre-cells are somewhat granular. At some points it is encroached upon by the cell-growth from the outer coat, between which and

Fig. 526.



Syphilitic arteritis. Shows section of small cerebral artery near a gumma, magnified 30 diameters. *a*, lumen of vessel; *b*, boundary of inner middle coats; *c*, thickened inner coat; *d*, middle coat; *e*, external coat; *f*, infiltrated pia mater. (After Greenfield.)

Fig. 527.



Syphilitic arteritis. Section of small artery of cerebellum, magnified 30 diameters. *a*, lumen of vessel; *c*, thickened inner coat; *d*, muscular coat; *e*, outer coat. (After Greenfield.)

the muscular coat there is no distinct line of demarcation. The outer coat is somewhat irregularly thickened by cell-growth, which is especially abundant around the vasa vasorum, which are very numerous and much more developed than usual. At some points small vessels traverse the muscular and elastic coats, going into the deeper portions of the thickened intima.

Fig. 528.



Syphilitic arteritis. Segment of the preceding specimen, magnified 170 diameters. *a*, lumen of vessel; *b*, fenestrated membrane; *c*, thickened intima; *d*, muscular coat; *e*, adventitia; *g*, new-formed imperfect elastic lamina. (After Greenfield.)

The inner coat measures twice the thickness of the outer and middle coats together. Starting from the fenestrated membrane, in its neighborhood there is found a rather abundant cell-growth traversed by capillaries. Nearer the intima is found a fibrous tissue, formed of elongated, fusiform cells and delicate, interlacing fibrils of connective tissue, the whole constituting an imperfectly developed fibrous tissue. Internal to this are seen more numerous, rounded cells, some of which are of larger size. Nearer to the lumen are seen elongated, oval nuclei, smaller and more highly refractile, and more closely packed together. It will be seen, by reference to my own case already given, that in the changes which occurred in the intima it was analogous to Dr. Greenfield's first case, while in the irregular, nodulated condition of the muscular layer it was analogous to his second.

In cases of constitutional syphilis, W. R. Gowers has studied the development of syphiloma in its relations to the arterioles. He concludes that the inflammatory material travels in the line of the vessels in the membranes of the brain. "These processes (of inflammatory matter) follow the course of vessels, and an examination of the points of the processes shows that the extension of the growth occurs along the perivascular canals."

According to Greenfield, the inflammatory matter in and around the perivascular canals in syphilis is entirely different from that in tubercular infiltration of these canals.

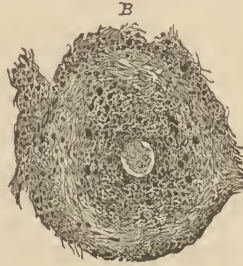
In vessels examined by Barlow, the same changes are reported as those given above (Figs. 529, 530). The adventitia and muscular coats were more or less affected, "but obviously the principal changes have taken place in the intima." Davidson and Buzzard are led to the same conclusions with the foregoing, as is Green in his "Pathology and Morbid Anatomy."

Heubner¹ holds that the process of new cell-formation in the intima, which has just been described at length, is due to the direct irritation of the current of the poisoned blood upon the endothelia. The inflammation progressing, proliferation of the intima increases, projections into the lumen occur, and

Fig. 529.



Fig. 530.



Syphilitic arteritis. Transverse section of a segment of the middle cerebral artery of a syphilitic patient. *i*, the thickened intima; *e*, the endothelium; *f*, the fenestrated membrane; *m*, the muscular coat; *a*, the adventitia. (From Barlow's Specimens, Green's Pathology.)

Syphilitic arteritis. Section from a small artery of the pia mater cut transversely, showing the inner coat much thickened, a diminution of the lumen of the vessel, and a considerable infiltration of the adventitia. A clot is seen to occupy a great part of the lumen of the vessel. (From Barlow's Specimens, Green's Pathology.)

narrowing or occlusion is the result. As the endothelial layer is lifted by this undermining, inflammatory process, a lateral projection into the lumen of the vessel (a vegetation) takes place, which may be the starting point of a thrombosis, or of cerebral anaemia. Heubner holds that these lateral, projecting vegetations of the internal membrane are pathological conditions appertaining especially to syphilitic arteritis.

It is asserted that syphilitic arteritis can be diagnosticated from atheroma during life. Lancereaux, according to Simes and White, in their edition of Cornil on Syphilis, says that the difference can be recognized chiefly by the occurrence of thrombosis in young subjects, without evidence of disease in other arteries. The knowledge that the patient has syphilis is a valuable aid to differentiation. (It is not difficult to agree with Lancereaux in this conclusion.) Moreover, atheroma is developed especially in the larger arteries, while the syphilitic process is found in the smaller, and by preference in the cerebral vessels; and, lastly, the young suffer from syphilitic arteritis more frequently than from atheroma.

I agree with the last-named observer that the differential diagnosis during life of the two arterial lesions, syphilitic and atheromatous, is extremely difficult, if not impossible. Moreover, these lesions very often exist at the same time.

Of the 22 cases quoted in the table from Greenfield, after excluding seven in which the condition of the arteries was not noted, we find that of the remaining fifteen, in thirteen there was atheroma of the aorta (and some of the

¹ Cornil on Syphilis.

smaller vessels), in one there was arteritis deformans, and in only one of the cases noted was there no coexisting atheroma.

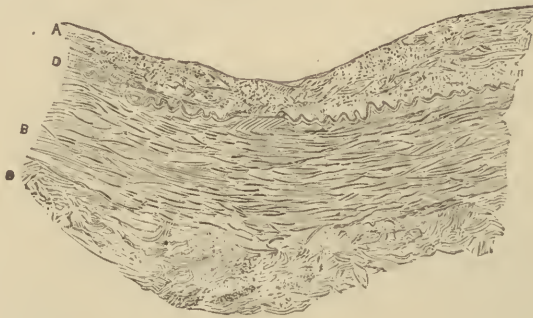
Since atheroma is a disease resulting from malnutrition of the vessel walls, and since syphilis is a blood-impoverishing disease, it can be easily conceived that atheroma of the larger arteries would occur in the later stages of syphilis, after the arteritis proper to this disease had been established in the smaller and remote arteries.

While the atheromatous process commences in the deeper tissues, advancing in the line of blood supply to the arterial walls, producing fatty infiltration of the elastic tunic and degeneration of the muscular fibre-cells and of the cells of the intima, and while in severe cases the normal tissues disappear, and the vessel dilates to such an extent that the artery (despite the temporary thickening of its walls, due to the inflammatory process) is much larger in calibre than normal, the syphilitic process is especially prone to attack the intima, and, while it is not entirely confined in its depredations to this coat, the changes it produces are never as constant in the other coats as in this.

Atheroma causes a weakening of the walls and general or saccular dilatation; syphilitic arteritis tends to more or less complete occlusion of the vessels, due to inflammatory cell new-formation (chiefly) of the intima. And while the inflammatory process may be somewhat aided by the direct irritation of the poisoned blood current passing along the vessel in contact with the intima, I believe that this inflammatory poison travels chiefly in the line of blood supply through the vasa vasorum.

RHEUMATIC ARTERITIS.—Arteritis may occur in connection with acute rheumatism. Bryant states that this is a rare form of disease. Rheumatic endo-

Fig. 531.



Arteritis with chronic nephritis. Section from posterior tibial artery of patient dead from Bright's disease, showing at A a great thickening of the intima, the result of chronic endarteritis. The elastic lamina D unchanged. The muscular layer B slightly thickened. C, adventitia greatly thickened at places by small-cell infiltration. Drawn from specimens prepared by Dr. W. L. Wardwell at Cohnheim's Laboratory. (Magnified about 40 diameters.)

carditis is not so rare, and it is possible that endarteritis may exist in the aorta in many cases of endocarditis. This and the arteritis of gout and nephritis (Fig. 531) belong to the domain of medicine, rather than to that of surgery, and will not therefore be considered in this work.

The *treatment of arteritis* resolves itself simply into the treatment of the disease of which it is a part. It would be useless to increase the length of this article by a recapitulation of the various methods and remedies which have been employed. If the pathogeny and pathology of the affection are understood, its therapy is not difficult.

ARTERIAL THROMBOSIS AND EMBOLISM.—Though not as frequent as in phlebitis, thrombosis and embolism often result from arteritis. The pathology of thrombosis has been given in the section on phlebitis. The process in the arteries is closely analogous to that in the veins.

The perfect type of thrombosis from acute, traumatic arteritis, is found after the application of an occluding ligature around an artery.

By reason of arrest of the blood current and disturbance of the equilibrium normally existing between the blood and the containing vessels, coagulation takes place on the cardiac side of the ligature, extending back as a rule to the first collateral branch. Immediately following the injury to the vessel, the process of inflammation—true arteritis—commences. The tension of the ligature to such a degree as to divide the inner or middle coat, or both, is unnecessary. I have tied arteries (carotid and subclavian) in human beings, and in horses and dogs, and have specimens which demonstrate successful occlusion of the vessel without division of either of the three tunics.

Scarpa advanced this idea years ago, but surgeons generally have decried it. None the less is it true, and I am fully convinced by experience that it is safer than the division of one or two coats of a vessel by tightly drawing a narrow, cutting ligature around an artery.¹

The coagulation thrombus disappears by fatty degeneration. The permanent occlusion is due to new formed tissue springing from the normal cells of the intima. O. Weber held that the clot became organized into a true tissue, into which bloodvessels were projected from the vasa vasorum (Fig. 532).

Fig. 532.



Longitudinal section of the artery of a dog fifty days after the ligature. Clot injected. Magnified 40 diameters.
(After O. Weber.)

But Cornil and Ranvier long since disproved this assertion of Weber. Bubnoff held that the white blood corpuscles emigrated through the walls of the ligatured vessel, permeated the clot, and caused its organization, but Durante (Cornil and Ranvier) has demonstrated that the leucocytes only traverse the walls of the vessel when this has been tied with a double ligature causing a death of the included vessel, and that the leucocytes travel through this dead tissue. They do not permeate the walls of an otherwise healthy artery which has been tied with a single ligature.

Cell proliferation takes place rapidly in the intima; granulation buds pro-

See cases by the author in *Archives of Medicine*, New York, June, 1882.

ject into the territory occupied by the clot (Fig. 533); bloodvessels derived from the vasa vasorum permeate the projecting granulation tissue, invade the clot, meet with live vessels from the opposite side, and join with these in a continuous circulation; the embryonic tissue organizes, gradually contracts (process of cicatrization), and the walls of the vessel are permanently occluded by this fibrillation. Afterwards, the new formed vessels disappear to a great degree, being obliterated by the contracting tissues.

Fig. 533.



Tranumatic endarteritis. Transverse section of the femoral artery of a dog eight days after the application of a ligature. *e*, the elastic lamina; *p*, the media; *b*, granulation bud projecting from the intima into the lumen; *v*, new formed vessel running through the inflammatory tissue. At *a*, the elastic layer has partly disappeared. Magnified 30 diameters. (From Cornil and Ranvier)

Fig. 516, from a section of the carotid of a horse, shows how this rapid proliferation of the normal cells of the intima occurs when the intima has not been divided. There was in this case simply an irritation of the intima, a bruising, the result of jamming together the opposing surfaces of the intima by means of a broad (not cutting) ligature.

Indeed, if argument be needed to strengthen this position, how unanswerable is this: that this process of proliferation of the intima into granulation projections is so extensive in some case of peri-arteritis that occlusion by thrombosis occurs. Here surely there is no division of the coat, not even contact of surfaces, but an inflammation of the intima resulting from pre-existing peri-arteritis.

Thrombosis from acute arteritis is rare. Chronic arteritis is not unfrequently the cause of occlusion. Syphilitic arteritis is apt to develop thrombosis of the cerebral arteries. Arterial thrombosis (excluding the vessels to the brain and walls of the heart) is not as dangerous to life as venous thrombosis.

The process is usually so gradual that the collateral circulation is established before occlusion of the main trunk occurs. This may indeed escape observation until the enlarging superficial arteries attract attention.

I have elsewhere reported a case illustrative of this fact. The occlusion was the result of chronic arteritis with calcareous degeneration. The popliteal was occluded from its bifurcation into the anterior and posterior tibial

vessels, and back to the origins of its superior articular branches, and the only chance of collateral circulation was through the anastomotica magna of the superficial femoral, together with the recurrent tibial and a muscular branch from the upper part of the popliteal. The circulation through these was perfect and sufficient.

The thrombus formed under such conditions differs from the organized thrombus at the seat of a ligature, inasmuch as the passing blood-current furnishes fibrin-making white corpuscles with accompanying fibrin-deposit in the one, while this cannot occur after a ligature is applied.

The detachment of particles of thrombi (emboli) and the accidents resulting therefrom do not fall within the province of this article. They are fully discussed in the articles on pyæmia, gangrene, etc.

The causes of thrombosis may be summed up as follows: (1) Occlusion of the vessel as by a ligature. (2) Inflammation of the intima (arteritis). (3) Dilatation of the vessels (as in aneurism). (4) An abnormal condition of the blood. (5) Heart failure. (6) Narrowing of the calibre of an artery by pressure.

VASCULAR TUMORS.

We may recognize six varieties of vascular tumor, apart from true aneurism. These are: (1) Arterial varix; (2) Cirroid arterial tumor, or cirroid aneurism; (3) Arterial cutaneous tumor; (4) Capillary cutaneous tumor; (5) Venous cutaneous tumor (these three varieties are usually classed together under the name of *angiomas*); and (6) Venous varix, or simply varix (varicose vein).

ARTERIAL VARIX may be defined as a dilatation and elongation of an artery of the second magnitude (as the external iliac or common carotid), of the third (as the external carotid or posterior tibial), or of the fourth (as the temporal, facial, superior thyroid, or palmar branches of the radial and ulnar). Cruveilhier has reported a case of *arterial varix* of the external iliac artery. I have made one dissection of *arterial varix* of the superior thyroid artery, in which this vessel was greatly elongated, and as large as the external or internal carotid. It was tortuous, but not sacculated, the dilatation being general. Tillaux¹ reports a case of *cirroid aneurism* of the hand with dilatation of the arteries of the forearm and humeral region.

Treatment.—Arterial varix may be treated by compression, or by the ligature, when such a procedure becomes necessary. In a case which I saw after the patient's death, and in which the superior thyroid artery was involved, the ligature would have been advisable. The artery was in a healthy condition, with the exception of its increased length and calibre.

When connected with *cirroid arterial tumors*, the solidification of these by ligature, cautery, or injection, will usually cure or palliate the arterial varix.

CIRROID ARTERIAL TUMOR, OR CIRROID ANEURISM.—The *Cirroid Arterial Tumor*, I would define, after Robin and Gosselin, as being an elongation and dilatation of the terminal subcutaneous arterioles (normally of a diameter of about $\frac{1}{10}$ of an inch). These tumors may be general or circumscribed. A single arteriole may be affected, as shown in a drawing in the Museum of St. George's Hospital, copied in Holmes's System of Surgery, or many arterioles may be involved, as in Mussey's remarkable case, and in others included in the accompanying table (page 808).

¹ Gaz. des Hôpitaux, 1882, p. 1083.

The term *cirroid aneurism* was introduced by Breschet, in a paper presented to the Academy of Medicine, at Paris, in 1832. By him it was applied to the condition of varicosity involving the larger arterial trunks, their branches, and the terminal arterioles. Robin, at a later date, introduced the name of *cirroid arterial tumors*, and defined these as varicosities of the terminal (subcutaneous) arterioles.

English writers have adopted the term employed by Breschet. By them it is usually considered "a form of disease which consists in a simultaneous elongation and dilatation of an artery. The structure of its wall exhibits in the beginning no alteration, although the coats become thinned during the progress of the enlargement. The middle coat of the artery is especially affected. It becomes pale and thin, so that the arteries look like veins. The dilatation is commonly equal throughout the circumference of the artery. In more severe cases the artery is greatly dilated, and presents unequal, saccular pouches, which are in fact so many true aneurisms, projecting usually towards the surface of the skin" (Holmes).

Gosselin¹ adopts the nomenclature of Robin, and considers the disease heretofore known as cirroid aneurism as only involving the terminal arterioles. The causes of *cirroid arterial tumors* are not positively known. They occur most frequently upon exposed surfaces of the body, as on the neck, head, and hands. The face and head are most frequently the seat of all forms of vascular subcutaneous and cutaneous tumors. Excluding those of the orbit, I have collected more than 90 cases in which the carotid arteries were tied for these lesions.

Polaillon reports fourteen cases of cirroid aneurism of the hand. The influence of exposure of an unprotected surface to atmospheric changes is worthy of consideration. Either peripheral or central disturbances of the functions of the vaso-motor nerves may lead to loss of tone in the muscular walls of the arteries. Frost-bite and blows have been mentioned as causes of cirroid aneurism. Berger reports a case of cirroid tumor of the hand caused by irritation, from constant pressure of an instrument which the patient used in his trade. The disease may also be congenital, or may result from the increased growth of a cutaneous nævus. Gosselin cites two cases of this kind. He holds that the presence of nævus indicates a congenital predisposition to vascular dilatation, and is not sure but that a subcutaneous arterial dilatation, at first not recognized, may exist simultaneously.

According to Holmes, cirroid arterial tumor occurs most frequently between the ages of fifteen and thirty. Wardrop's patient, whose case is given by Gosselin as one of cirroid arterial growth, was operated upon the sixth week after birth. Wardrop gives this case as one of "erectile tumor." Chelius operated for "aneurismal varix of the temporal region" in a child of twelve months.

Symptoms.—The *clinical history* of cirroid arterial tumors does not commence with the pathological changes which occur in the terminal arterioles. Dilatation begins before there is any appreciable projection of the skin, or pulsation, or twisting of the arterioles. At a later period, the physical signs are present, and the diagnosis easy. Direct pressure will arrest the pulsation and empty the tumor. The consistency of these tumors varies with the amount of the connective tissue developed around the arterioles, as a result of the inflammatory process. Petit describes the sensation imparted to the palm of the hand pressed upon an arterial cirroid, as similar to the vermicular motion of a mass of earth-worms.

With the stethoscope, a bruit de souffle is distinctly audible. Pain is not

¹ Archives Générales de Médecine, 1867.

constant, and is only due to the pressure of the growth upon the cutaneous nerves. As the tumor progresses in size, more marked inflammatory changes occur; adhesions to the skin take place; and ulcerations, with alarming hemorrhages, are not infrequent. In some instances, especially in cirroid tumor of the scalp, pressure of the growth upon the calvaria may interfere with the nutrition of the skull.

Treatment.—It may be said of the treatment of cirroid arterial tumors, in common with arterial, capillary, and venous cutaneous tumors, that no method is as safe or sure as direct local treatment. The study of a large number of cases leads me to this conclusion. For a long time deligation of the main trunk or trunks was the favorite practice. Sometimes this was done to arrest hemorrhage due to ulceration or accident, in some few cases to arrest hemorrhage after or during an attempt at removal, but most frequently the intention was to cut off the blood-supply. Since the vast majority of vascular tumors occupy the neck, face, and scalp, the carotids have been often tied in the treatment of these growths. In my "Essays in Surgical Anatomy and Surgery,"¹ I have collected 803 cases of deligation of the carotid. Not including 60 cases of intra-orbital aneurism (pulsating vascular tumor within the orbit), there were 98 cases of ligature of the carotid for vascular growth above the clavicle, and chiefly of the head. The results are not such as to encourage the careful operator in a repetition of the procedure.

By reference to the Table accompanying this paper, and which, with the exception of a single case (that of McBurney), is taken from my work on the Arteries, the results may be studied in detail. At the risk of repetition, and in order to emphasize the above remark, it may be said that of 73 cases in which the common carotid was tied, almost 30 per cent. proved fatal, and the proportion of patients that were cured out of 51 who recovered from the operation (about 50 per cent.), is not encouraging. Deligation of a main trunk, I am convinced, is only justifiable in case of hemorrhage which cannot be arrested by any other means, or after all other methods have been essayed.

As to the efficacy of the ligature of the parent trunk to arrest dangerous and accidental hemorrhage, the case of Dr. Edward Bradley, of New York, may be cited. In the attempt to remove a large vascular tumor of the parotid and submaxillary region, such alarming hemorrhage occurred that it became necessary to tie the common carotid before the operation was fairly under way. A cure resulted, although the operation of removal was not completed.

Two patients, operated on by Pirogoff, on account of hemorrhage due to ulceration, recovered, and another (a child) died from recurring hemorrhage after it had been carelessly taken out of the reach of surgical aid. Jüngken's patient recovered, and Heine's case of cirroid aneurism was cured by ligature of the carotid and excision of the mass, the external carotid having previously been tied. Dewar's case was cured. The common carotid artery in all these cases was tied to arrest hemorrhage. G. Burke cured a case by ligature of the external carotid, and direct application of the actual cautery to the tumor.

Both common trunks were tied in nine cases. The operators were Blackman, Gunderloch and Müller, Kuhl, Mussey, Pirogoff, Robert, Rodgers and Van Buren, Ullman, and Warren. The interval between the two operations varied, and is given in the table. Remarkable as it may seem, only two of these patients died. Of the seven who recovered, one was cured (not however until after compression was made over the tumor), and two were improved. Mussey's patient was only improved after the second ligation, but was cured

¹ New York, 1879.

after a bloody excision. The tumor was exceedingly large, and the dilated arteries were tied one by one. More than twenty ligatures were applied, and the hemorrhage is said to have been dangerously profuse.

Other surgeons, besides Mussey,¹ who have practised excision of cirroid arterial and other "vascular tumors," are Bradley,¹ Busch,¹ Heine,¹ Graefe,² Gibson,² Buchanan,³ Sydney Jones,⁴ Warren,¹ Weitzer,² Guéniot,² and Hart.² The latter froze the tumor, and cut well into sound tissue; little blood was lost. The late Prof. Spence, of Edinburgh, cured a deep-seated erectile tumor of the hand by galvano-puncture.⁵ Nélaton operated in a cirroid tumor of the forehead in a similar way, and with like success.

Barwell operates upon vascular tumors by what is termed the *scarless method*.⁶ Having carefully made out the limits of the tumor, a needle armed with a silver wire is passed under the skin, and subcutaneously around the outskirts of the tumor, to a point opposite the place of entrance. The needle is again introduced at the point from which it has just emerged, and is carried around the remainder of the tumor, and out at the first point of entrance. The base of the tumor is thus looped by a wire which can be tightened beneath the skin at will. Barwell uses a slot of vulcanized rubber which he slides down upon the wire to tighten it around the tumor. If the growth be very large, he advises the needle to be brought out at frequent intervals.

Direct, local compression has been tried by patient and expert surgeons, but has not met with success.

Gosselin⁷ in his classical paper reports several successful cases in which he employed hypodermic injections of perchloride of iron into the mass. This idea was original with Broca, who applied the styptic endermically with success. Pitha, of Prague, and Schuh, following Broca, thus cured three cases (Gosselin). Berger⁸ reports a case of cirroid aneurism of the hand treated by this method. Velpeau, Gherini, and Demarquay have performed the same operation. In Demarquay's case, the radial and ulnar arteries had been tied.

The method of procedure is as follows: The tumor must be compressed, so that while the circulation ceases the growth remains full of blood. This condition must be maintained for at least ten minutes after the injection. The syringe being filled, the air is carefully excluded, and the needle is introduced about a quarter of an inch into the mass, when the solution is discharged. Kneading, to disseminate the fluid, is then practised, and the finger is placed upon the hole made by the needle, or the needle and syringe may be left in, during the ten minutes.

Pain is immediately present, and persists for several hours. After an interval of ten or fifteen days, the operation may be repeated, if necessary. Eight or more operations have been required to effect a final cure. Ulceration may follow, but it is usually limited. At times, unhealthy granulations bud up from these ulcerating patches, requiring repeated burning with nitrate of silver or with the actual cautery.

In one of Gosselin's cases, hemorrhage was so frequent and persistent that deligation of the parent vessel—the femoral—was at one time considered, but this was happily avoided by repeated use of the actual cautery.

Gosselin's cases were three in number:—

CASE I.—*Cirroid Arterial Tumor of the left Leg*.—The patient was a woman, aged 25. At birth she had a small red stain or spot in the skin at the upper and anterior

¹ See the author's Essays in Surgical Anatomy and Surgery. New York, 1879.

² Holmes's System of Surgery, 2d ed. vol. iii. p. 540.

³ British Medical Journal, June, 1875, p. 835.

⁴ Medical Times and Gazette, Aug. 21, 1875, p. 209.

⁵ Archives Gén. de Médecine, tom. ii. 1867, p. 636-659.

⁶ Gazette des Hôpitaux, 1882, p. 1082.

⁷ Lancet, 1882.

⁸ Lancet, May 8, 1875, p. 642.

part of the left leg, which up to her twelfth year had grown about as large as an almond. At 15 she first noticed that pulsation began in it. After this date it grew more rapidly, projecting, however, very slightly from the surface, until, at the age of 22, it began to ulcerate without any assignable cause. Hemorrhage occurred, which ceased by compression, but not until syncope had ensued. Repeated bleedings occurred up to her twenty-fifth year, when the injections were commenced. From July 12 to August 23, seven injections were made. Ulceration began, and frequent hemorrhages occurred between October 12 and 18, which were arrested by the actual cautery and compression. Cure resulted at the end of eleven months.

CASE II.—*Cirroid Arterial Tumor of the Forehead with Arterial Varices; Hemorrhage during many years; four Injections of Perchloride of Iron; Cure.*—Patient was a man, aged 39; was born with a red mark on his forehead, which disappeared at his tenth year. About nineteen years later, when in his twenty-ninth year, a tumor was noticed in the same place, about as large as a cherry stone, and two years later he felt it begin to pulsate. After that time it continued to grow, and was the source of frequent hemorrhages without any direct injury or known cause. The patient had controlled the bleeding by compression. At the time of operation, the growth was about two inches in diameter, and projected from the skin about one-third of an inch. February 12, while pressure was made on both primitive carotids, injections were made with two syringes, one needle being introduced on each side of the tumor. The compression of the carotids was continued ten minutes. The tumor still pulsated at points. Compress applied; pain was severe during the day of operation and the next day following. Operation repeated on the 1st of March. March 13, tumor was solid and without pulsation throughout two-thirds of its extent. Two injections made. March 20, tumor began to ulcerate at two limited points, which were soon filled with exuberant granulations. These resisted alcoholic dressings and the application of nitrate of silver. March 24, pulsation re-appeared at one point, and the injection was repeated. May 20, the granulations persisting, actual cautery was applied. Same on June 6. July 8, patient discharged, cured.

CASE III. does not differ materially from the two preceding cases, either as to its clinical history or as to its treatment.

The results of this method of treating vascular tumors are gratifying, and the operation is worthy of repetition. In growths of small size, I should prefer to try the method of Barwell, and, if this failed, then the injection of perchloride of iron or other coagulating solution. The success achieved by Spence and Nélaton with galvano-puncture was such as to justify further trial of this method.

Cases of spontaneous cure of vascular tumors are reported. Dr. Krackowizer presented to the New York Pathological Society a patient in whom pulsation had entirely ceased in a cirroid tumor which was contracted, solid, and shrivelled at various points; the peculiar rustling noise, also, of which the patient had complained, was now entirely absent when he was quiet. The man was forty-five years of age; the tumor was congenital, and had grown to a considerable size, but without pain or hemorrhage. Dr. Krackowizer referred to two other cases recorded by Orfila and Chevalier.

TABLE OF CASES IN WHICH THE COMMON CAROTID ARTERY HAS BEEN TIED ON ACCOUNT OF ANEURISM BY ANASTOMOSIS AND ARTERIAL VARIX. (NOT INCLUDING ANASTOMOTIC OR PULSATING TUMORS OF THE CAVITY OF THE ORBIT.)

No.	Name of operator.	PATIENT.			Nature of disease.	Duration of disease.	Date of operation.	Hæmorrhage after operation.	Lig. came away No. of days after operation.	RESULT.			REMARKS.
		Sex.	Age.	Side.						As to life.	Local condition.	Cause of death, date after oper'n.	
1	Arendt, 1821	M.	35	R.	Aneurism anast. of face.	.....	Nov. 18, 1821	6 weeks.	17	Recovered.	Cured.	.....	The secondary hæmorrhage lasted for several days, but was slight; 12 ligatures were applied during the operation.
2	Auchincloss, 1839.	...	23	L.	Aneurism anast. of head.	23 years.	1839	.....	20	Recovered.	Cured.	.....	Pulsation in tumor ceased immediately; cure rapid.
3	Aubert, Moscow.	F.	y'g	R.	Aneurism anast. of ear.	.....	.....	Some days.	.....	Died.	.....	Inflammation brain.	Tumor began to decline; pain in head; hemiplegia; death.
4	Bernhard, 1833.	F.	39	R.	Aneurism anast. near ear.	8 years	Mar. 26, 1833	.....	.....	Recovered.	Cured.	.....	No cerebral symptoms.
5	Bertherand, 1860.	F.	4½ mos.	L.	Erectile tumor of temporal region.	4½ mos.	.....	.....	.....	Recovered.	Cured.	.....	External carotid tied first; as tumor was not affected, common carotid was tied and first ligature removed. No cerebral symptoms followed.
6	Busch, 1819.	M.	34	L.	Aneurism anast. of head and face.	.....	May 10, 1819	.....	12	Recovered.	Improved.	.....
7	Bushe, 1830.	M.	19	L.	Erectile tumor of cheek.	19 years.	Jan. 15, 1830	.....	29	Recovered.	Cured.	.....
8	Blackman, 1843.	M.	30	R.	Fungous tumor of neck.	2 years.	Jan. 21, 1843	.....	.....	Died.	.....	8th day (exhaust.)	
9	Blackman, 1848.	M.	15	R.	Fungus hæmatod.	do.	.....	.....	13	Recovered.	.....	.....
10	Blackman, 1848	M.	15	L.	do. do.	do.	.....	.....	14	Recovered.	(Uncertain).	.....	Same case as No. 9.
11	Chelius, 1836.	M.	19	R.	Aneur. varix. of temporal region.	1 year.	Jan. 18, 1836	.....	21	Recovered.	Cured.	.....
12	Cherry, 1858.	F.	12	..	Erectile tumor.	.....	.....	.....	.....	Recovered.	Cured.	.....
13	Deguisé, 1827.	F.	.....	..	Erectile tumor.	.....	.....	.....	.....	Died.	.....	.....
14	Devar, 1860.	F.	27	R.	Hem.; pulsating tumor of tonsil.	.....	June 2, 1859	.....	14	Recovered.	Cured.	.....	Syphilitic diathesis.
15	Detmold, Prof. Wm., 1840.	F.	26	R.	Vascular tumor of right side head.	.....	1840	.....	16	Recovered.	No improvement.	.....	Operation made no impression on tumor; died 18 months afterwards of phthisis.

CASES IN WHICH THE COMMON CAROTID ARTERY HAS BEEN TIED.—Continued.

No.	Name of operator.	PATIENT.			Nature of disease.	Duration of disease.	Date of operation.	Hemorrhage occurred after operation.	Lig. came away No. days after operation.	RESULT.			REMARKS.
		Sex.	Age.	Side.						As to life.	Local condition.	Cause of death, date after oper'n.	
16	Detmold, 1842.	M.	.....	L.	Vascular tumor of chin.	.....	1842	.....	10	Recovered.	Cured.	.....	After ligation, tumor laid open and hot iron applied.
17	Detmold, 1845.	...	8 mos.	L.	Aneurism anast. of left ear.	.....	1845	.....	10*	Recovered.	Cured.	.....
18	Dupuytren, 1845.	M.	20	R.	Erectile tumor of ear and temple.	.....	April 8, 1818	.....	12	Recovered.	.....	.....	Same case as No. 20.
19	Gunderlach, 1831.	...	5½	R.	Aneurism anast. of frontal and nasal regions.	5½ years.	Sept. 13, 1831	.....	13	Recovered.	Not cured.	.....
20	Möller, 1832.	...	.....	L.	do.	5½ years.	Jan. 18, 1832	.....	28	Recovered.	?	.....	Patient died subsequently of variola.
21	Grandchamp, 1839.	F.	50	R.	Pulsating tumor of face.	2 years.	1839	.....	.....	Recovered.	.....	.....
22	F. H. Hamilton, 1860.	M.	2	R.	Erectile tumor of outer angle of right eye.	6 weeks.	Feb. 12, 1860	.....	.....	Recovered.	No benefit.	.....	During previous year, the two facials, the transverse facial, infra-orbital, and temporal artery of the affected side were tied, with no effect upon tumor. No cerebral symptoms followed ligation of common trunk. Tumor covered right temple, had pushed eye out and destroyed it; soft, elastic, with distinct bruit; tumor returned subsequently, and patient died from it. No symptoms of cerebral disturbance.
23	Hart, 1861.	M.	11	L.	Aneurism anast. of upper lid and orbit.	.....	1861?	.....	8	Recovered.	Cured.	.....
24	Heine, 1869.	M.	21	...	Hem'ge; removed cirroid aneurism of ear and scalp.	5 days.	1869	.....	.....	Recovered.	Cured.	.....	External carotid tied when tumor was removed; five days after, hemorrhage and ligation of common carotid. No cerebral symptoms.
25	Jobert, 1836.	M.	.....	R.	Erectile tumor in temporal region.	4 mos.	Aug. 22, 1836	.....	.....	Died.	.....	Second day.	
26	Jüngken.	M.	19	R.	Hem., aneurism by anastomosis.	.....	.....	.....	16	Recovered.	Not cured.	.....	Patient died 9 months after operation from pneumonia. One year after a fall from a horse on occiput; hemorrhage 72 days after first operation. The second carotid tied; no marked cerebral symptoms followed the second operation, although convulsions occurred after the first.
27	Kerr, 1840.	F.	67	R.	Vascular tumor; supposed aneur.	.....	April 30, 1840	.....	26	Recovered.	.....	.....
28	Kuhl, 1843.	M.	53	L.	Aneurism anast. occip. traum.	24 years.	May 24, 1843	Sev. times.	27	Recovered.	Not cured.	.....	The second carotid tied; no marked cerebral symptoms followed the second operation, although convulsions occurred after the first.
29	Kuhl, 1843.	M.	53	R.	do.	do.	Aug. 4, 1843	3d day.	27	Recovered.	Cured.	.....

CASES IN WHICH THE COMMON CAROTID ARTERY HAS BEEN TIED.—Continued.

No.	Name of operator.	PATIENT.			Nature of disease.	Duration of disease.	Date of operation.	Hæmorrhage occurred after operation.	Lig. came away No. days after operation.	RESULT.			REMARKS.
		S.	M.	Age.	Side.					As to life.	Local condition.	Cause of death, date after opera.	
30	Kuhl, 1836.	F.	43	R.	Vascular tumor of frontal region.	4 mos.	Sept. 16, 1836	.....	.....	Died.	.....	Second day.	Cerebral symptoms followed; unconscious four hours. Autopsy: Tuberculosis of lungs; pneumogastric nerve injured by inflammation of surrounding structures; right subclavian included in ligature by mistake.
31	Lenoir, 1851.	F.	y'g	...	Erectile tumor of temporal region.	.....	.....	.....	15	Died.	.....	.....	Fungus of left cerebral fossa; petrous portion temporal bone carious; internal jugular vein obliterated.
32	Lisfranc, 1827.	F.	18	R.	Fungus hæmated. (supposed aneurism).	.....	.....	After.	.....	Died.	.....	8th day. Hemorrhage. 10th day.	
33	Liston, 1841.	M.	20	L.	Vascular tumor of neck.	.....	.....	After.	.....	Died.	.....	Hæmorrhage. 19th day.	
34	Lücke, 1866.	M.	66	L.	Spontaneous pulsating tumor of forehead.	7 years.	Aug. 9, 1866	14, 16, 17th day.	.....	Died.	.....	Hæmorrhage. delirium.	Delirious after operation. Autopsy: Ulcerated hole in carotid at ligature.
35	Maisonneuve.	F.	30	R.	Varicose aneurism of parietal reg., traumatic.	2 mos.	.....	.....	.....	Died.	.....	Third day.	External carotid was tied first; this lig. fell 16th day. The sup. thyroid was tied at this time. Hemorrhage again occurring, the internal and common carotids were tied, followed by complete left hemiplegia. Autopsy: Right hemisphere softened, the sympathetic nerve included in both the internal and common carotid ligatures (<i>P/z</i>).
36	Maunoir.	M.	30	L.	Cirroid aneurism.	.....	Before 1821	.....	.....	Recovered.	No improvement.	.....
37	Mayo, 1833.	M.	5 mos.	L.	Erectile tumor of face.	5 mos.	1833	.....	8	Recovered.	Improved.	.....
38	McClellan, 1825.	F.	9	L.	Erectile tumor of cheek.	.....	1825	.....	14	Recovered.	Cured.	.....
39	McClellan, 1829.	M.	43	L.	Aneurism anast.; Seve- trum of nose.	Seve- ral years.	May 12, 1829	.....	.....	Died.	.....	12 days. Cerebral complications.	Paralysis (right) 24 hours after operation; 8th day coma; death in convulsions.
40	Michels, 1835.	F.	23	L.	Aneurism anast. of face and occiput.	2 years.	Mar. 12, 1835	.....	30	Recovered.	Cured.	.....	Patient was 3 months pregnant at time of operation; did well.
41	Millies.	...	.....	...	Aneurism, fusiform; superior thyroid.	.....	.....	.....	.....	Died.	.....	Four days.	Died suddenly; no autopsy.

No.	Name of operator.	PATIENT.			Nature of disease.	Duration of disease.	Date of operation.	Hemorrhage occurred after operation.	Life, same day after operation.	RESULT.			REMARKS.
		Sex.	Age.	Side.						As to life.	Local condition.	Cause of death, date after oper'n.	
42	Mussey, 1827, New Hampshire.	M.	20	R.	Erectile tumor of scalp.	.....	Sept. 20, 1827	.....	.....	Recovered.	Not improved.	.....	Tumor afterwards removed; patient lost 2 quarts blood, and more than 20 ligatures were required
43	Mussey.	M.	20	L.	do.	.....	Nov. 2, 1827	.....	.....	Recovered.	Improved.	.....	Same case as No. 42.
44	Mott, Prof. Valentine, New York.	...	C'd	...	Aneurism anast. of orbit and nose.	.....	.....	.....	.....	Recovered.	.....	.....	Tumor had crossed bridge of nose and invaded portion of opposite eye.
45	Mott.	...	3 mos.	...	Aneurism anast. of neck and jaw.	.....	.....	.....	.....	Recovered.	.....	.....
46	Mott, 1830.	...	C'd	...	Aneurism anast. of temple.	.....	1830	.....	15	Recovered.	Improved.	.....
47	Mott, Prof. A. B., 1854.	F.	6½ mos.	L.	Aneurism anast. of left side of face.	.....	Feb. 1, 1854	.....	17	Recovered.	Cured.	.....
48	Mott, A. B.	F.	7 yrs	R.	Fungus hematod. at orbit.	.....	April 10, 1854	.....	.....	Recovered.	Cured.	.....	Eye was extirpated at same time; no return after two years.
49	Mott, A. B., 1856.	F.	23	L.	Aneurism anast.	.....	Oct. 30, 1856	.....	21	Recovered.	Cured.	.....
50	Mott, A. B., 1859.	F.	9 mos.	R.	Large aneurism anast. over parotid gland.	.....	Jan. 20, 1859	.....	14	Recovered.	Cured.	.....
51	Willard Parker, 1857.	F.	4½ yrs	L.	Erectile tumor of face.	4½ years.	April 6, 1857	18th day.	21	Recovered.	?	.....	Hemorrhage on 18th day controlled by moderate pressure.
52	Parker, 1861.	F.	10 mos.	R.	Extensive vascular tumor of face.	10 mos.	April 29, 1861	None.	12	Recovered.	Cured.	.....	Three years after operation, patient was perfectly well.
53	Pirogoff, 1843.	M.	20	L.	Hem.; aneurism anastomosis of occipital and temporal region.	.....	Jan. 16, 1843	.....	5	Recovered.	Improved.	.....	At six years of age, small tumor of scalp. In 1843, attempt to remove it resulted in such alarming hemorrhage, that Pirogoff tied carotid. Tumor not entirely disappearing by following year, remaining carotid tied. Tumor was then treated by compress, and cured.
54	Pirogoff, 1844.	M.	20	R.	do.	.....	Jan. 9, 1844	.....	16	Recovered.	Cured?	.....	Same case as No. 53.
55	Pirogoff, 1837.	...	9 mos.	L.	Erectile tumor, occiput.	9 mos.	Jan. 26, 1837	Occurred.	.....	.....	.....	117th day.	Hemorrhage.
56	Pirogoff.	M.	Mid. age.	L.	Hem.; aneurism anast.	.....	.....	.....	.....	Recovered.	?	.....

CASES IN WHICH THE COMMON CAROTID ARTERY HAS BEEN TIED.—*Continued.*

No.	Name of operator.	PATIENT.			Nature of disease.	Duration of disease.	Date of operation.	Hemorrhage occurred after operation.	Lig. came away No. days after operation.	RESULT.			REMARKS.
		Sex.	Age.	Side.						As to life.	Local condition.	Cause of death, date after oper'n.	
57	Pirogoff.	..	C'd	L.	Hem.; aneurism anast.	.....	.....	After.	.....	Died.	.....	Hemorrh'ge	Child was doing well; mother removed beyond reach of surgical interference when hemorrhage occurred, causing death.
58	Post, Prof. A. C., N. Y., 1845.	M.	27	R.	Telangiectasis right cheek.	Many years.	April 1, 1845	.....	.....	Died.	.....	Phlebitis; pyæmia; delirium.	Autopsy: Two phleboliths were found in tumor. Phlebitis of int. jugular, although vein was not wounded in the operation; pus in vein.
59	Randolph, 1833.	M.	25	R.	Aneurism varix.	.....	1836	.....	.....	Died.	.....	Next day. Cerebral complications.	Coma soon after operation.
60	Robert, 1846.	F.	19	L.	Aneurism, cirroid, frontal region.	19 years.	June 5, 1846	.....	19	Recov-ered.	.....	.....	Slight cerebral symptoms followed each operation, but passed away.
61	Robert, 1847.	F.	19	R.	do.	19½ years.	Feb. 22, 1847	.....	18	Recov-ered.	Marked benefit.	.....	In May, 1850, there was no pulsation in the tumor. Same case as No. 60.
62	Robert, 1857.	M.	.....	L.	Aneurism, cirroid.	.....	.....	.....	.....	Died.	.....	A few days	.....
63	Rodgers, J. K., 1844.	F.	11	R.	Aneur. by anast., head.	.....	.....	.....	.....	Recov-ered.	Not cured.	.....	Temporal artery was also tied. (See No. 70.)
64	Rogers, D. L., 1832.	...	8 mos.	R.	Erectile tumor of face.	8 mos.	Dec. 12, 1832	.....	.....	Recov-ered.	Cured.	.....	.....
65	Southam, 1864.	F.	28	R.	Aneur. by anast. head.	8 years.	May 20, 1864	.....	14	Recov-ered.	Cured.	.....	No anæsthetic; ulcerated, and hemorrhage before operation.
66	Thebaud, J. S., 1865.	...	6 mos.	...	Aneurism anast. of face and eye.	.....	.....	.....	10	Recov-ered.	Not cured but benefited.	.....	.....
67	Unknown, 1823.	M.	19	L.	Erectile tumor in region of left ear.	.....	1823	.....	.....	Recov-ered.	Not cured.	.....	Same case as No. 68.
68	Ullman, 1824.	M.	20	R.	do.	.....	1824	Twice.	.....	Died.	.....	3d day. Exhaust'n	On account of hemorrhage, a second ligature had to be applied lower down.
69	Unknown, Hotel Dieu.	M.	20	...	Cirroid aneurism of scalp.	.....	.....	.....	.....	Recov-ered.	Im- proved.	.....	Temporal articular, and occipital tied at same time.
70	Van Buren, 1850.	F.	17	L.	do.	.....	1850	.....	14	Recov-ered.	Not cured.	.....	Disease latent; right carotid had been tied six years previously by Dr. J. K. Rodgers. No cerebral symptoms followed. (See No. 63.)
71	Velpeau, 1835.	M.	16	L.	Erectile tumor of temporal region.	.....	1835	Often.	.....	Died.	.....	16th day. Hemorrh'ge.	Internal carotid was also tied.

CASES IN WHICH THE COMMON CAROTID ARTERY HAS BEEN TIED.—*Continued.*

No.	Name of operator.	PATIENT.			Nature of disease.	Duration of disease.	Date of operation.	Hemorrhage occurred after operation.	Lig. came away No. days after operation.	RESULT.			REMARKS.
		Sex.	Age.	Side.						As to life.	Local condition.	Cause of death, date after oper'n.	
72	Warren, 1845.	M.	23	L.	Erectile tumor of face and neck.	.....	Oct. 5, 1845	.....	.....	Recov-ered.	No bet-ter.	.....	Tumor diminished about one-half after first ligation, but there was no positive improvement.
73	Warren, 1845.	M.	23	R.	Erectile tumor of face and neck.	.....	Nov. 9, 1845	.....	.....	Recov-ered.	Im-proved.	.....	Tum. afterward treated by removing a portion and plunging needles into remaining parts. Cured.
74	Wardrop, 1818.	...	6 wks	L.	Erectile tumor of cheek.	6 weeks.	1818	.....	.....	Died.	.....	14th day.	Tumor ulcerated freely after operation.
75	Wardrop, 1826.	F.	5 mos.	L.	Erectile tumor of face.	.....	March, 1826	.....	11	Recov-ered.	Cured.	Exhaust'n	
76	Wardrop, 1827.	M.	22	L.	Erectile tumor of face and head.	12 years.	Oct. (?) 1827	.....	25	Recov-ered.	Im-proved.	.....	Died 103 days after operation; psosas abscess.
77	Wardrop, 1842.	M.	6 mos.	R.	Aneurism anast. of cheek.	6 mos.	Mar. 2, 1842	.....	9	Recov-ered.	Not cured.	.....	Three years after operation, but little change in tumor.
78	Woodward, A. T., 1860.	F.	6 mos.	L.	Aneurism anast. of left external carotid.	Some time.	.....	.....	.....	Died.	.....	4th day.	
79	Wutzer, 1847.	M.	25	...	Aneurism anast. external carotid.	.....	.....	.....	18	Recov-ered.	Cured.	.....	On account of numerous branches going into tumor, deemed impracticable to tie ext. carotid.
80	Zeiss.	...	15 mos.	L.	Erectile tumor of face.	15 mos.	.....	.....	8	Died.	.....	114 days.	
81	Paul, John, 1830.	F.	28	R.	Pulsating tumor above ear.	.....	July 29, 1830	.....	15	Recov-ered.	Cured.	Cere. com.	
82	Bradley, E., New York, 1877.	M.	20	L.	Hemorrhage during removal of vascular tumor of parotid and submaxillary regions (Angeloma).	19½ years.	Dec. 6, 1877	None.	3d week.	Recov-ered.	Cured.	.....	Tumor grew rapidly within the last year. In operation for removal, while dissecting with the handle of the scalpel, the tumor gave way, and a frightful hemorrhage occurred. The common carotid was tied immediately above the clavicle, the incision being made behind the posterior border of the mastoid muscle. Hemorrhage ceased instantly. The recovery was prompt, and the tumor has entirely disappeared. After ligation of the common trunk the tumor was not removed, but the wound was packed with lint soaked in Monsel's solution. No symptoms of cerebral disturbance.

The *internal carotid* has never been tied for any of the lesions given in the preceding Table, except in the cases reported by Maisonneuve and Velpeau,

TABLE OF CASES IN WHICH THE EXTERNAL CAROTID ARTERY HAS BEEN TIED ON ACCOUNT OF THE LESIONS MENTIONED IN THE PRECEDING TABLE.

No.	Name of operator.	PATIENT.			Nature of disease.	Duration of	Date of operation.	Hemorrhage occurred after operation.	Lig. came away No. days after operation.	RESULT.			REMARKS.
		Sex.	Age.	Side.						As to life.	Local condition.	Cause of death, date after oper'n.	
1	Bertherand, 1860.	F.	4½ mos.	L.	Erectile tumor of temporal region.	.....	.....	.....	.....	Recovered.	Cured.	.....	External carotid first tied some hours before common. As the effect on the tumor was not marked, this last vessel was tied and the ligature removed from the external. (As the ligature was tightened and remained several hours <i>in situ</i> , it is probable that the vessel was obliterated by the operation, the inner coat being cut and turned in as is the rule in such cases. — <i>Author</i> .)
2	Busch, W., 1872.	F.	29	R.	Pulsating vascular tumor back of head.	24 years.	Aug. 25, 1872	.....	15	Recovered.	.....	.....	Patient writes Dec. 20, 1873: "Am not able to work; appetite good; sleep badly; pulsation in tumor; place is not so well as when I was discharged." Hemorrhage from the sloughing tumor some time after oper., only very slight. Same case as No. 2.
3	do.	F.	29	L.	.....	.....	do.	.....	16	Recovered.	Not cured.	.....	Pressure and hot iron had been tried to arrest hemorrhage before ligature. No hemorrhage after operation.
4	Bushe, G., 1827.	F.	2½	R.	Hem. after removing pulsating tumor temporal region.	.....	1827	None.	13-18	Recovered.	Cured.	.....
5	V. Bruns, 1856.	M.	25	R.	Vascular tumor left cheek, lip, and nose.	.....	1856	.....	20	Recovered.	.....	.....
6	do.	...	.....	L.	do.	.....	.....	.....	10	Recovered.	No benefit.	.....	Same case as No. 5.
7	Heine, C., 1869.	M.	21	...	Hem. cirroid tumor scalp and ear.	.....	.....	Severe.	.....	Recovered.	Cured.	.....	Five days after ligature of external carotid, on account of hemorrhage, the common carotid was tied. Hemorrhage from seat of ligature.
8	Maisonneuve 1849.	F.	30	R.	Aneurism anast. temporal region.	2 mos.	.....	After.	16	Died.	.....	.....	21 days after ligature of external carotid, hemorrhage; 26th and 27th, hemorrhage, then ligature of common and internal carotid; sympathetic nerve included in last ligature. Hemiplegia ensued after ligature of common trunk.

CASES IN WHICH THE EXTERNAL CAROTID ARTERY HAS BEEN TIED.—*Concluded.*

No.	Name of operator.	PATIENT.			Nature of disease.	Duration of disease.	Date of operation.	Hæmorrhage occurred after operation.	Lig. came away No. days after operation.	RESULT.			REMARKS.
		Sex.	Age.	Side.						As to life.	Local condition.	Cause of death, date after oper'n.	
9	Mastermann,	F.	16	R.	Aneurism anast. ear.	5	Recovered.	Cured.	Part of tumor ligatured also, and part cut away and nitrate of silver applied. Pulsation ceased after operation, but tumor did not decrease much in size; 3 months after operation, patient much improved. Several smaller vessels tied at same time.
10	McBurney, New York, 1882.	M.	12	L.	Cirroid of auricle of ear.	.....	.....	.....	.....	Recovered.	.....	.....
11	Roser, 1856.	F.	.....	R.	Varicose aneur. of left ear.	.....	1856	.....	.....	Recovered.	Cured.	.....
12	Sédillot.	..	.....	..	Vascular growth of head and face.	.....	.....	None.	.....	Recovered.	.....	.....
13	Wallace, 1838.	F.	13	R.	Nævus of right cheek.	.....	.....	None.	15	Recovered.	Improved.	.....
14	Wutzer, 1841.	M.	41	L.	Fungus of palate.	Once.	19-22	Recovered.	Hæmorrhage after operation from the occipitalis.
15	Wutzer, 1847.	M.	38	R.	Fungus of neck and fauces.	.....	.....	.....	16	Recovered.	.....	.....

In the preceding table are collected 73 cases, in which—either as a means of cure or to prevent hemorrhage before or after removal of *aneurism by anastomosis*, *vascular* or *erectile tumor*, *fungus* or *fungus hæmatodes*, or *cirsoid aneurism*—the ligature was applied to the *common carotid artery*. The number of arteries tied was 82, both being operated upon in 9 patients. This does not include 60 additional cases in which this artery was tied for pulsating tumor of the orbit.¹ Taking these cases as one group—as vascular growths—it will be seen that of the total of 73, death resulted in 21 instances. Of the 51 patients who recovered, 27 are noted as cured, 10 as improved, 5 as not improved, while 9 are noted as recovered, but either not cured, or with the result, otherwise than as regards life, not mentioned.

If these cases are subdivided into three classes, taking those reported as *aneurism by anastomosis*, *vascular growth*, and *erectile tumor* as one class, *fungus hæmatodes* as another, and *arterial varix* as a third, we shall be better able to arrive at a safe conclusion as to the relative merits of this operation in the several groups of cases.

In 59 patients the common carotid was tied on account of *aneurism by anastomosis* and *vascular* or *erectile tumor*. Death resulted in 16 instances. In one of these fatal cases the operation was performed to arrest hemorrhage, and in another both carotids were tied. Of the 43 recoveries, 24 were reported as cures. In two of these cases the cure was not effected until both the common trunks had been tied. One tumor was laid open after the artery had been tied, and the actual cautery applied. In another case the artery was tied during the extirpation of the tumor. Seven patients recovered, and were noted as “improved,” and in the cases of two of these, both common carotids were tied. Three of the patients who recovered are noted as “not improved,” and nine as “recovered,” with no other information as to the result, with the exception of two, who were “not cured.” In one of the cases noted as a recovery, the operation was required to arrest hemorrhage, and two others were cases of double ligature of the carotids.

For *fungoid vascular growths* 4 cases are given: 2 patients died; 1 was “cured,” after the orbit and surrounding structures had been removed and the wound cauterized; and in one case of double ligature it is merely noted that the patient “recovered.”

Ten cases of *arterial varix* are reported, with 2 “cures,” 3 “recoveries with improvement” (one a case of double ligature), and one “recovery without improvement.” In one case which was cured, the varix was extirpated, and in one, which proved fatal, Maisonneuve had previously tied the external carotid without favorable result.

The results in the foregoing cases are not sufficiently encouraging to justify the ligature of the common carotid for these lesions. Exceptional cases will, however, occur, in which pressure and other means fail, which may demand even this dangerous procedure.

Of the 13 instances in which the *external carotid* was tied for the lesions heretofore mentioned (the artery of the two sides being ligated in two cases), none proved fatal excepting the operation of Maisonneuve, in which the common carotid was also tied (the sympathetic nerve being included in the ligature by accident).

The external carotid alone was tied in 10 patients (the double operation being performed in two instances). All recovered. Busch tied the two trunks: the patient recovered, but was not cured. Von Bruns did the same operation, and met with a like result.

¹ See author's *Essays in Surgical Anatomy and Surgery*, p. 127. New York, 1879.

G. Bushe removed a pulsating growth, and tied the external carotid to arrest the hemorrhage. The patient recovered and was cured.

Mastermann tied the artery, ligated a portion of the tumor, and cauterized the remainder with nitrate of silver, with a cure.

Roser tied the artery and a cure resulted. Sédillot's patient "recovered." Wallace's was "improved." Wutzer's two cases "recovered," and McBurney's has been much improved, with a great probability of a permanent cure.

ANGEIOMATA.—The three next varieties of "vascular tumor," which may be grouped together under the name of *Angeiomata*, are: (1) the *Arterial Cutaneous Tumor*, or *Aneurism by Anastomosis*, composed of dilatations or elongations of the arterioles, either normal or new-formed, in the skin; (2) the *Capillary Cutaneous Tumor*, consisting of dilatations and elongations of the normal or new-formed capillaries of the skin; and (3) the *Venous Cutaneous Tumor* (*Cavernous Nævus*, or simply *Nævus*), composed of dilatations of the normal or new-formed venous radicles of the skin.

The angeiomata are considered by some writers as strictly new-formations of bloodvessels. There is little doubt, however, that many vascular tumors are chiefly made up of normal vessels which have undergone dilatation or hypertrophy. Other names that have been given to angeiomata are congenital nævus, erectile tumor, telangiectasis or plexiform angeioma, aneurism by anastomosis, ecchymoma, cavernous nævus, and fungus hæmatodes. According to Depaul, one-third of the children born in one of the eleemosynary institutions at Paris, had congenital nævi, the greater number of which disappeared spontaneously during the first few months of life. They occur chiefly in the skin, and are especially apt to appear on the forehead, face, ears, and neck.

Structure and Symptoms.—Angeiomata commonly form flattened, slightly projecting tumors, varying in size from a mere speck to as much as an inch in diameter, and are composed of new-formed, dilated, freely anastomosing capillaries, arterioles, and veins, in irregular, labyrinthine masses. They vary in color, being at times grayish-blue or red. Often the only indication of their presence is the appearance of a diffuse redness over a considerable surface. Examined microscopically, the walls of the vessels are crowded with cells, and the vessels are imbedded in a network of fibrous and adipose tissue. The superficial and deep cutaneous vessels—including the vessels of the hair follicles, sweat glands, and adipose tissue—join in the formation of these tumors. The disease may extend into the muscles and deeper tissues.

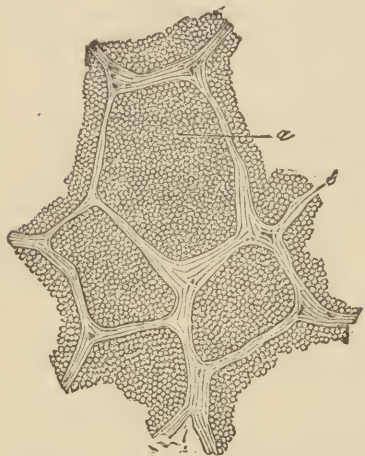
The majority of angeiomata are soft and yielding, and can be emptied by pressure; but when of great vascularity and long standing, when there has been an extensive proliferation of the perivascular connective tissue, pressure will not cause their disappearance. Some are very painful, and others entirely free from sensibility.

Venous cutaneous tumors are composed, in great part, of new-formed, erectile tissue, analogous to that found in the corpora cavernosa. The structure is white and dense, the caverns communicating freely with each other. These at times are found to contain the chalky concretions which have been considered on a previous page as *phlebolites*. The circulation is active in these tumors, and their volume variable.

The walls of the sinuses contain a dense, fibrous stroma, involuntary muscular tissue, and striated muscular fibres when the tumor is encroaching on the muscles. They are lined by the same endothelium as the normal veins. In specimens removed and immediately immersed in alcohol, which causes instant coagulation of the blood in the sinuses, it is found that the blood pre-

sents the same appearances as the normal blood, but that the white corpuscles are less numerous. They do not adhere to the walls of the vessels. This is con-

Fig. 534.



Cavernous angioma of the liver. Section made after the tumor had been immediately submerged in alcohol: *a*, cavernous spaces filled with blood-corpuscles; *b*, fibrous walls of the sinuses. Magnified 150 diameters. (From Cornil and Ranvier.)

sidered as proof of a rapid circulation, since in veins where the circulation is weakened or retarded, the leucocytes tend to adhere to the walls. After excision the vessels contract, forcing out their contents, and the mass shrinks to a comparatively small size.

These tumors are not all erectile, and some which have been erectile for a time lose this property. Gross describes a form of naevoid tumor as *naevoid elephantiasis*, consisting of a hypertrophied condition of the skin and subcutaneous connective tissue. The affection, which is either congenital or comes on soon after birth, is found usually in the lower extremities, though it may occur elsewhere.

The theories as to the origin of these neoplasms are various. Some hold that simple dilatation of contiguous veins occurs, when, the sacculated vessels coming in contact, the walls are absorbed, and thus many cavities which formerly were separate, form one or more large, multilocular, cavernous tumors. These dilatations occur not only in the skin and subcutaneous tissues, but also in bone and muscle. No tissue can be considered exempt. Rokitsansky holds that they originate in the areolar tissue, from embryonic, new-formation tissue, and that the vascularization of this new tissue is one of the last processes of its development. He compares the alveoli of the cavernous angioma to those of carcinoma.

Rindfleisch believes that the appearance of these tumors is preceded by a proliferation of embryonic material in the intervascular spaces, and that this material, undergoing the usual process of cicatrization and contraction, causes a shrinkage in the intervascular areas, when the vessels dilate to occupy the space left vacant by the contracting tissues (Billroth).

Cornil and Ranvier say that in the active development of angiomas there is a proliferation of embryonic tissue, rich in new-formed vessels, which, increasing rapidly in size, come in contact and communicate with each other by absorption of contiguous surfaces.

Angiomas may develop in fatty and other neoplasms. Billroth mentions a case in which a large cavernous angioma was found in a lipoma removed from the scapular region. They have been known to originate as a result of injury. Gross cites a case, reported by Dr. J. Mason Warren, of a man thirty-six years old, who had a large aneurism by anastomosis, situated on the lobe of the ear, which resulted from a frost-bite which the patient had suffered in his sixteenth year. In addition to the tissues already mentioned in which angiomas are developed, may be mentioned the spleen, kidney, liver, and lung. The liver is frequently, the lung very rarely, involved. In bones, this disease exhibits the same erectile characters as in other structures. It occurs in the flat bones by preference, especially those of the cranium, jaws, and scapula, being often very painful, and grave as to prognosis. Angiomas are not infrequently situated on the labia of women. Holmes Coote has observed serous cysts in connection with these vascular growths. An explanation of their formation is, that communication of a portion of one dilated



Rapidly growing Naevus involving both skin and deeper tissues.
(From a patient at the Children's Hospital, Philadelphia).

vessel with other vessels is cut off, and that the corpuscles and coloring matter of the blood disappear, the serum remaining as a cystic fluid.

The question of the relation of these tumors to carcinomata and sarcomata is worthy of consideration. J. Müller has reported a malignant (recurrent)

Fig. 535.



Aneurism by anastomosis in parietal bone. (Erichsen.)

angioma. A case of melanotic degeneration of a congenital nævus in a woman aged forty has been reported by Dr. Stiles. The vascular dilatations in osteo-sarcomata and in other forms of carcinoma and sarcoma are analogous to those found in cavernous angiomata. Some of the malignant tumors pulsate like the angiomata. An angioma may be diffuse or encapsulated.

The *prognosis* depends upon the size and location of the neoplasm.

The *diagnosis* is not difficult in the superficial tumors, but in those deeply situated, and in the track of large vessels, the differentiation from aneurism is not easy.

The arterial and capillary cutaneous tumors are almost always congenital; the venous tumors are rarely so. Angioma may be distinguished from osteo-sarcomata which have perceptible pulsation, by the crackling impression conveyed to the sense of touch from the malignant tumors of bone.

Several consecutive telangiectases may occur in the same individual. Hutchinson, of London, reports the case of a child which had over one hundred nævi, all distinct and superficial. Vascular tumors on the scalp have an element of danger not present in angioma elsewhere, in that they at times grow to such an extent as to cause necrosis of the calvaria.

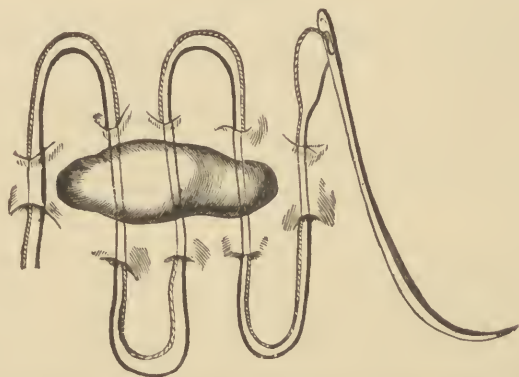
Treatment.—Angioma have been known to heal without surgical interference, as a result of an idiopathic inflammation. Transfixion and multiple deligation is one of the most radical and successful methods of treatment. Direct and prolonged pressure has been employed, though not with encouraging results. Perforation with hot needles, either with or without the galvanic current, injection of coagulating fluids, particularly Monsel's solution, or of ergot, local applications of nitric acid or other escharotics, and extirpation by the knife, have all been practised. Vaccination over the growth has effected a cure in a few cases.

In treating superficial angioma, not too extensive, and not situated where the cicatrix would prove a deformity, Billroth prefers nitric acid. For extensive simple and cavernous angioma, he recommends the knife or scissors.

Hemorrhage is to be controlled by pressure, rapid use of forceps, or preliminary ligature.

Angeioma of the face is best relieved by the clean cut of the knife, and the cicatrix is less deforming than that produced by other modes of treatment. I recently removed a growth of this kind from the forehead of a young woman. The incision was made down to the bone, and the tissue removed was more than one inch long by three-quarters of an inch in width. The hemorrhage was insignificant, and the edges united by first intention with an imperceptible cicatrix. Of course the operation is not justifiable if telangiectasis involves more surface than can be covered by stretching or sliding the sound integument. When the skin is not deeply involved in the disease, a crucial incision may be made, and the skin dissected off, and replaced after the tumor has been ligatured and removed. In cavernous tumors of large size the method of Erichsen is advisable. A long straight or slightly curved needle, armed with a double thread, one-half of which is stained black, is passed through the tumor at its base, and deeply from side to side. This process is repeated at intervals of three-quarters of an inch, until the entire angeioma is transfixd with threads which are parallel with each other. The loops are then divided—the black on one side and the white on the other—and tied tightly until the strangulation is complete. It is advised to blacken one-half of the thread, so that in tying the knots a mistake may not be made. The black and white threads are tied separately.

Fig. 536.



Erichsen's method of introducing the double ligature for the cure of vascular tumors.

For my own part, I prefer complete and radical excision in all angeiomata of the face and exposed portions of the body, the removal of which would not cause too great or perceptible deformity. The wound should be carefully adjusted with sutures.

In cavernous tumors of large size, the method of Erichsen is preferable. If these operations are not admissible, then direct pressure or deligation of the main trunk may be resorted to.¹

VENOUS VARIX, VARIX, OR VARICOSE VEIN.—This variety of "vascular tumor" consists of a dilatation and elongation of the deep or subcutaneous veins. This condition may exist in any portion of the body, even in the bones (Cornil and Ranvier). It may involve a small portion of one vein, superficial or deep, or, as is most usual, a chain of veins. It is most frequently observed in

¹ For further remarks on the treatment of angeiomata, see the section on Cirroid Arterial Tumor and the observations following the table of cases there given.

the superficial veins, though Verneuil says that varix is really as common in the deep-seated as in the superficial vessels (Bryant). It is especially prone to occur in the saphena veins. Hemorrhoids and varicoceles are common forms of varix. Unusual types are the dilatation of the jugulars from stenosis of the vena cava descendens, and that of the superficial abdominal veins from stenosis of the ascending cava. Such conditions are described by some authors as simple hypertrophies or dilatations of veins. Any long-continued dilatation constitutes a varix. Hyperplasia of the normal tissues of the venous wall is the natural sequence of prolonged pressure and increased function. The hypertrophy of the wall is not always equal to the resistance of the increased pressure; hence sacculated pouches occur when the vessel wall becomes much thinner than normal, not infrequently resulting in rupture. Varix is of frequent occurrence in women who have had repeated pregnancies (Billroth).

Poorly-fed and hard-worked persons, especially those who work in the upright posture, are more prone to varix than others. There can be no doubt that gravitation is the chief and immediate cause of this disease. The veins most subject to the greatest, prolonged blood-weight, and least protected by pressure, are involved in the great majority of cases. Paralysis of the muscular walls, either by atrophy of the muscles or interference with the function of the *nervi vasorum*, may cause varix. This is proven by the fact that a small segment of a single vein in the upper portion of the body, where the anastomosis is free and gravitation cannot be considered as a factor in the dilatation, may be the seat of this affection.

Mr. Gay says that "with superficial varicosity there are other serious lesions affecting both arteries and veins, deep and superficial, such as would lead to the conclusion that the general circulation has been subject to a very considerable and long-standing embarrassment, some incompetency of the arterial system, or impediment to the venous, or both combined" (Bryant).

In well-marked *varix* the veins are greatly increased, not only in calibre but in length, so that they seem coiled and twisted upon themselves in knotted masses. They are narrowed in calibre at frequent intervals, these contractions opening into expanded pouches, in general appearance not unlike the sacculated large intestine. The valves are wholly inefficient, often flattened against the wall, or at times partially destroyed. At the level of the valves the walls are exceptionally thickened. The thickening is due to a multiplication of the muscular elements and hyperplasia of the connective tissue. The connective-tissue new formation is abundantly distributed in the meshes of the elastic network, and the bundles of fibres are usually arranged parallel with the long axis of the vessel. This accounts for the longitudinal ridges seen on the inner surface of the affected veins (Cornil and Ranvier). Even the nutrient vessels of the walls of these varicose veins—the *vasa vasorum*—have undergone hypertrophy, and are themselves the seat of varix, forming at times venous caverns in the wall of the vessel, which communicate with the vein. The internal tunic is not, properly speaking, thickened, except at the points of attachment of the valves, or when a thrombus has formed.

Immediately external to the middle elastic tunic, the muscular tissue appears increased in quantity, arranged in transverse and perpendicular laminae, separated by bundles of hypertrophied connective tissue, which are not infrequently stained with granular pigment. Calcareous deposits occur primarily within or between these connective-tissue bundles (Cornil and Ranvier).¹

¹ In the arteries, these deposits occur first around and within the nucleus of the unstriped muscle, and gradually increase until they fill the cell, which becomes converted into a small calcareous flake (Green). See section on Arteritis.

Hyperplasia of the connective and other tissues in the immediate vicinity of a varix of long standing, presents the usual appearances of phlegmon and elephantiasis. Small spots of ulceration occur as a result of malnutrition, and, coalescing, form the large and obstinate ulcers seen so frequently in varix of the legs. Even a new formation of bone may result from the irritation of a neighboring varicosity (Cornil and Ranvier). The veins become greatly elongated and assume different shapes, irregularly sinuous or corkscrew-like, twisted upon their axes, and frequently, on account of perivascular inflammation, matted together by new-formed connective tissue into venous tumors. Occlusion of varicose veins may result from thrombosis, and a cure may thus ensue. Frequently concretions are found in varicose veins, at times adherent to the walls. These concretions are called *phlebolithes* or *phlebolites* (Dunglison). They are laminated on section, and are said to contain by analysis twenty per cent. of protein matter, with phosphate and sulphate of lime and sulphate of potassium (Franklin and Bryant), and, according to Gross, a trace of oxide of iron. They are found most frequently in the veins of the pelvis, about the bladder and prostate, especially when the latter is enlarged. Hodgson says that they are formed in other tissues, and work their way into the vessels. This theory would seem to receive a partial support from the statement just made that they are most frequently found near the prostate, and when this organ is diseased. It is well known that small calculi are frequent in this body. I have removed, after death, as many as a dozen from ulcerated pouches in a single prostate. Phlebolites are also found in veins not subject to varix. Cruveilhier believed that they were developed from coagula (Holmes).

It may be deduced from these various statements, that, as a rule, these masses are formed from the blood in an abnormal condition, by a process of calcareous degeneration. Occasionally, extra-vascular concretions may find their way into the veins, more especially those of the prostatic and vesical plexuses.

Treatment.—Varicose veins are to be treated chiefly by artificial support to the weakened and dilated walls. Eczema and the various forms of ulcer occurring in connection with varix are relieved by proper support. The varix, however, is not often cured by this means alone, which is merely palliative. Martin's elastic bandage is of great use. Bandages of muslin or flannel, properly applied, give great relief. The elastic, knit-worsted apparatus, for constant, equable pressure, cleanliness, and comfort, cannot be surpassed in the treatment of varix. The relief of pressure by position is always advisable. All supporting apparatus should be removed at bedtime and adjusted before rising. The only method of radical cure is by occlusion. This must be accomplished by inducing coagulation of the blood. It is never without an element of danger, since phlebitis is apt to occur. I have used, with benefit, the hypodermic injection of the fluid extract of ergot into the perivascular tissues. The patient was partially relieved, but I was fearful of thrombosis, and desisted after two operations. The use of a subcutaneous, metallic ligature, the wire being passed under and not through the veins, and acupressure, are the most approved methods. The cases are, however, exceedingly rare where such procedures are justifiable. Numerous deaths have followed from the phlebitis or thrombosis which has resulted from these operations. Varices have also been opened and burned with the actual canterbury, tied between two ligatures and cut out, treated by compression after incision, etc. Paré speaks of the danger of interfering with varices, lest suffocation should occur. He had probably seen some cases of pulmonary embolism.

Caustics have been used by Mayo, Brodie, Key, and others (Bryant),

and this is the treatment employed by S. D. Gross, who recommends issues made over the varicosity by repeated applications of Vienna paste. His method is to take pieces of the paste as large as a three-cent coin, only much thicker, and to place them directly over the tortuous and enlarged vessels, at intervals of three, four, or five inches, and allow them to remain for fifteen minutes, at the end of which time the skin and connective tissue will be found to have been thoroughly destroyed. The paste is then removed, and the parts washed with vinegar to neutralize any excess of the alkali. Poultices are applied to accelerate the separation of the eschars, and to promote granulations. Prof. Gross says that the cure is usually somewhat tedious on account of the length of time required to heal the issues, but that this plan of treatment possesses the great advantage of being entirely free from danger, and always perfectly successful.

In spite of the commendation of this procedure by so eminent a surgeon, I am not willing to practise it or advise it. It is of necessity much more painful than cutting openly and directly down upon the varix, and tying the veins thoroughly. The cure, in this operation, must come from inflammation and occlusion, partial or complete. The chances of embolism and extensive phlebitis are certainly less than when the inflammatory process gradually approaches and involves a vessel through which the blood is flowing toward the heart. The application of Bozeman's button-suture, Isaacs's injection of subsulphate of iron, Bryant's tannin injection, and Bartholow's perivascular employment of ergotine, are other methods which have been resorted to in this affection.

MOLES.

Closely connected with the more superficial forms of vascular tumor are the abnormal, circumscribed hypertrophies of the skin, which are known as *moles*. They may be, and usually are, congenital, or they may be developed at any period of extra-uterine life. All portions of the cuticular surface may be subject to this form of hypertrophy, but the exposed surfaces, such as the face, neck, and hands, are most frequently affected. The hypertrophy which constitutes the mole may involve all or any one of the tissues which enter into the anatomy of the integument. The most frequent variety is that which occupies the face, as a simple elevation from which a few stiff hairs grow. It is not stained with pigment, and differs very slightly, if at all, in color from the normal skin. The lesion here is a true hypertrophy of all the tissues of the skin, chiefly in the derma and papillary layer. The vascularity is slightly increased, and the sebaceous glands connected with the hair follicles take part in the hypertrophy. On other portions of the body this form of mole (*naevus vulgaris*) will have no hairs growing from its surface.

Naevus pigmentosus is not usually a thickening of the entire cutis, as is the simple mole just described, but its pathological condition is an excessive deposit of pigment in the Malpighian layer and in the epidermis. It varies in color from a slate-gray to a blue, mahogany, reddish-brown, or wine color. At times the pigment mole will extend over a large area, occupying as much as one-third, or one-half of the face. The lobule of the ear, and the integument between the eyes and over the temple, is, in my experience, the most common location of this deformity. Another name for these spots is "*port-wine mark*."

When the hypertrophied area of skin is studded with hairs, it is known as *naevus pilosus*, or hairy mole. It follows from the name that this form of hypertrophy can only occur on those portions of the cutis in which the hairs grow. The plantar surfaces of the feet and the palms of the hands

are never affected. They may or not be stained with pigment. The majority of hairy moles are not colored.

Moles, whether simple, hairy, or pigmented, are benign. As a result of irritation they may inflame and become ulcerated, or may develop into malignant growths. Carcinomata, especially of the melanotic variety, are frequently described as having resulted from inflamed pigment moles. Alarming hemorrhage has been known to occur from a mole more than usually vascular, in which ulceration had been established by friction of the clothing.

Treatment.—As long as no deformity or inconvenience results from these formations, it is better to let them alone. When situated upon the face, of such size or position that they become offensive to the eye, they may be removed by simple excision. The incision should be elliptical, and well away from the growth, going entirely through the thickness of the skin. The wound should be closed with a delicate suture, or drawn nicely together with adhesive strips. I have removed as many as five from the face of one patient, and without leaving any perceptible trace of their location; and no bad result has ever occurred to my knowledge from this practice. The simplest method of procedure is to produce local anæsthesia by the ether spray, and operate quickly. *Port-wine marks*, that is, large pigment spots, may also be excised when the surgeon is assured that the resulting cicatrix will be a less deformity than the existing mole.

If a mole should at any time take on inflammatory action, or give any indication of malignant proliferation, immediate excision would be imperative, and the incision should be wide of the supposed area of the disease. The employment of caustics or irritants of any kind is to be deprecated, as they would increase the tendency to malignant change in these growths.

ANEURISM.

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DEFINITION AND CLASSIFICATION.

THE attempt to define aneurism encounters considerable difficulty, because many different forms of disease are included under that word; and because much of our terminology has descended to us from older writers to whom the circulation of the blood was unknown. Probably the only definition which, while excluding every other malady, includes all varieties of the disease in question, will be found to run thus: *Aneurism is a blood-tumor directly communicating with the interior of one or more vessels on the arterial side of the circulation.*¹ Some of these tumors are formed by more or less uniform dilatation of a certain length of a vessel, or of vessels, the blood being within the vascular lumen. Some are formed by blood lying outside the normal area of the circulation, but still inclosed in one or more of the vascular coverings; others are formed by blood which has become extravascular. Any of these forms may be complicated by preternatural communication with a vein, the disease being then termed *arterio-venous aneurism*.

But, although such distinctions are anatomical, and satisfy all requirements of definition, they are in a clinical point of view all but useless. To make out during life whether one or two of the vascular coats entirely include the blood of the tumor, or whether those coverings have given way over a larger or smaller spot, is impossible; and the distinction, could it be made, would be valueless. Sometimes, indeed, all the three coats will have yielded, and yet the blood be contained in a definite cavity, the tumor presenting the same signs as though one or more of the arterial coats persisted. Although I think, therefore, that certain anatomical distinctions had better be forgotten, or merely considered as curious historical lore, yet it is necessary in a work of this nature—as the names have not yet been relegated to the past—to give under a sort of protest the distinguishing terms of true and false aneurism, as applied to the different conditions of the arterial coats in this disease.

A “*True Aneurism*” is one in which all the three tunics of the vessel are entire and continuous throughout the tumor. A “*False Aneurism*” is that form in which one or more of the coats are no longer entire. Not only, however, is the distinction impossible during life, but in many instances after death also; for during the progress of disease the distended vascular coverings undergo such changes as to render them quite unrecognizable: they may some-

¹ I am of course aware that such a definition would include certain of the larger nævi (angiomata), as also some recent and increasing ecchymoses. But, as will be seen in the sequel, such angiomata are not anatomically distinguishable from small aneurisms by anastomosis, nor does such an ecchymosis, if the blood come from an arterial twig, differ from diffuse aneurism otherwise than by its size.

times be split into any number of coats, sometimes only one can be found, sometimes it is impossible to determine whether one of the coverings is a normal part or an entirely fresh formation.¹ Let us therefore at once, and throughout this article, discard the terms false and true aneurism, with the remark that a dilatation of the whole periphery of an artery is generally constituted by all the vascular coats. A protrusion or bulging of one side or aspect of an artery is, unless merely incipient, accompanied by rupture of one or more coats. Some writers have described a form of false aneurism—"hernial"—the existence of which is more than doubtful. It is, as its name implies, supposed to be formed by the bulging of the inner through an opening in the middle and outer coats. There is, I think, no doubt that a certain false lining often found in diseased arteries has been mistaken for a dilated inner coat, and that preparations supposed to illustrate this condition are the artificial productions of over-zealous dissection.

Better reason might be shown for the term diffuse aneurism, were it used in a more reasonable and consistent manner; but it is, unfortunately, applied to such tumors as are still circumscribed, if at any point the capsule appear to consist not of arterial coats, but of condensed adjacent tissue, and also to unlimited effusion of blood into cavities or tissues resulting from wound or rupture of a healthy or previously diseased artery. Some reform in this nomenclature is urgently needed, and will immediately be supplied. The clinical distinctions of aneurisms, borne out as they are by anatomical facts, are these:—

FUSIFORM ANEURISMS are such tumors as are produced by dilatation or expansion of the whole periphery of an artery. Whether this centrifugal dilatation be or be not uniform, it is always greatest at or about the centre, diminishing towards either end, where it joins the normal tube—it is, therefore, in form biconical or spindle-shaped. A less advanced form of the disease is sometimes termed *aneurismal dilatation*. Such aneurisms have, therefore, two communications with the rest of the vessel—the one proximal, the other distal.

SACCULATED ANEURISM is that form of the disease which is produced by the expansion of a limited spot on one aspect of an artery, and which has, therefore, but one foramen of communication with the circulating stream; this is nearly always beside the current, like a diverticulum or bay, and is called "the mouth;" around and adjacent to it is the "neck;" and the bulk of the tumor, always larger than the neck, is the "body" of the aneurism. The whole is inclosed by the "sac." A sacculated may spring from a fusiform aneurism, or from an aneurismal dilatation; in such cases the mouth is larger in proportion to the body than when the tumor arises from an artery of normal calibre. This form of aneurism may arise without any traceable immediate cause, and is then called *spontaneous*; or may result from injury—blow, strain, or even direct wound—when it is called *traumatic*, a term concerning which a few words must be said presently.

A DISSECTING ANEURISM results from an escape of blood through a rent in the inner coverings of an artery, while the outer envelopes are sufficiently strong to resist dilatation. The blood therefore percolates a certain, often a

¹ Mr. Erichsen says that a false aneurism may always be distinguished if on section the middle coat is seen to terminate abruptly in a dense ring immediately round the neck of the sac, and certainly it seems like a truism to say that the edge of a ruptured coat shows that rupture, that is, falsity of aneurism, exists; but I have seen many aneurisms, undoubtedly false, in which no such abrupt edge, no undoubted and definite place of demonstrable rupture, could be traced.

considerable, distance between the walls of the vessel, separating, as it were dissecting, one coat from another, or the two layers of the middle coat from each other. For a certain time, therefore, there is but one foramen of communication with the area of the vessel, but after a while the blood usually perforates the outer coverings and becomes effused; or may, making another breach in the internal tunics, find its way back into the circulation. This form of disease is almost confined to the aorta; but one or two examples have been seen to spread thence into the large branches springing from its arch.

ARTERIO-VEINous ANEURISM.—When any of these aneurisms communicates with a vein by an interparietal breach, the condition becomes "*arterio-venous aneurism*," which is of two sorts; when the opening is immediate, with no interposed cavity, the disease is "**ANEURISMAL VARIX**." When a cavity, blood-filled and circumscribed, opens into both vein and artery, "**VARICOSE ANEURISM**" is the term employed.

RACEMOSE OR CIRSOID ANEURISM and **ANEURISM BY ANASTOMOSIS** are dilatations of numerous and smaller branches, either supplied by one, or more commonly by more than one, vessel. The dilatation extends to what normally are minute ramifications, even capillaries, and affects not only the circumference, but the length of the vessels, which are therefore tortuous. The tumors consist of congeries of convoluted and irregularly dilated vessels twisting and freely anastomosing through a certain district of thinned and softened tissue.¹

DIFFUSED ANEURISM.—Any of the above forms of aneurism may, by rupture or erosion through some part of the sac wall, permit a greater or less escape of blood into the neighboring tissues; it is then called "diffused." We must in this place make a clear distinction: a sacculated aneurism often grows so rapidly that, at a portion of its periphery, all the arterial tunics incapable of such wide dilatation have given way, and a portion of the sac is formed by the adjacent tissues thickened by previous pressure, with perhaps inflammation, and reinforced by the coagulation of blood which has infiltrated among them. Bone, muscle, fascia, etc., may thus form a portion of the sac; but be it observed that there is a sac: the blood is encapsuled. On the other hand, it sometimes happens that the sac, however formed, gives way more completely, and permits the effusion of blood without limit among the tissues. The former condition is properly called a consecutive aneurism (Broca); the latter is often termed a diffuse aneurism; it is said to have become diffuse. I think that the term should be limited to small effusions slowly produced, and that the name "ruptured aneurism" would better represent the large and sudden outflow of blood which sometimes occurs.

It may be gathered from the above, that a diffuse aneurism may, if not too large, become re-encapsuled by coagulation of its outer portion, and by inflammatory thickening of the surrounding tissues. An arterial wound, for instance, may pour out a certain quantity of blood into the tissues; the skin opening may be closed by nature or art, while pressure may check the bleeding; the effused blood after a time becomes encapsuled, and the result is a *traumatic consecutive aneurism*.

The term traumatic diffuse aneurism, applied to a wounded or ruptured vessel filling the whole neighborhood with limitless (not encapsuled) blood, is evidently a misnomer; some sort of sac is inherent to the idea aneurism, and what has been so injudiciously named as above, is a wounded or ruptured

¹ This subject is treated of in the article on Diseases of the Vascular System.

artery with interstitial or subfascial hemorrhage. The term will not be used in this article.

Another distinction is drawn from the locality of the disease. *Internal* aneurisms are situated within the cranium, thorax, or abdomen, while those that make their appearance outside those cavities, or anywhere about the limbs, are named *external* aneurisms. The region in, or the artery on which, the tumor is situated, also confers a name on the disease: thus, intracranial, thoracic, or abdominal; axillary or popliteal; aortic, carotid, femoral, and so on.

CAUSES OF ANEURISM.

The *causes* of aneurism are (1) wound or violence,¹ and (2) any circumstances which disturb the relationship between the pressure of the blood and the retentive power of the vessels. Among the latter there may be certain predisposing as distinguished from direct or exciting causes, but they vary in different events; thus, for instance, atheroma may be merely a predisposing cause, if some violence produce the disease, but is in spontaneous aneurism more frequently the exciting, indeed the only direct, cause; the predisposing causation must then be sought in such conditions as may produce or tend to arterial degeneration. But little notice will, however, be taken of this time-honored division of causes, since it is, as regards aneurism, more pedantic than valuable.

WOUNDS.—Wounds inflicted by some sharp instrument, although they more commonly give rise to hemorrhage, may, by partial division of arterial coats, cause aneurism, which, if the vein be also implicated, may be arterio-venous, but may also, as the following case will show, be of the sacculated variety, if merely the artery be involved:—

CASE I.—A carpenter, aged twenty-six, was admitted into Charing Cross Hospital, under the care of Mr. Canton, in April, 1861. Three weeks previously a chisel which he was using slipped and penetrated the thigh, about the junction of the upper and middle thirds. Some smart but not profuse bleeding occurred, but was checked without deligation of any vessels; the wound healed quickly, and had closed six days before his admission. He came to show a “lump” which lay immediately under the cicatrix, and which was diagnosed to be an aneurism, for which the femoral artery was tied.

The man died; the arterial wound was found to have divided probably only a certain thickness of the outer coat.

EXTERNAL VIOLENCE, WITHOUT WOUND, is sometimes directly productive of aneurism. A familiar example of such casualty is found in the axillary aneurism which sometimes follows over-zealous attempts to reduce a dislocation of the shoulder. The vessel indeed may be entirely ruptured by such efforts. Sailors are said to be subject to axillary and subclavian aneurism, sometimes probably the effect of repeated over-exertion, often the result of some sudden effort, as preventing a fall by catching with one hand on a rope or spar. Violent traction by revolving machinery, which, having caught a limb, drags it into its gear, has several times been followed by aneurism. I have, from my own observation, reason to believe that the frequent falls and other mishaps of drunkards produce thoracic and abdominal aneurisms more frequently than is usually supposed. In such cases, it is probable that some form of degeneration may have weakened the arterial coats; perhaps alco-

¹ I avoid the word *traumatic* as in this case ambiguous.

holic paralysis, since the poison is in contact with the vascular walls, may affect their muscular fibres sooner than the voluntary organs, thus impairing elasticity and power of resistance. To this subject we must recur.

The second class of causes, namely, disturbance in the ratio between blood-pressure and strength of tunics, falls naturally into two subdivisions; the first is increased mass or pressure of the blood, general or local. I am not aware that either the plethora or the high arterial tension that accompanies Bright's disease has ever been shown to be directly productive of aneurism; and I must say the same of hypertrophy of the left ventricle.¹ Aortic aneurism and ventricular hypertrophy are frequently coexistent; but either may cause the other, and the walls of the vessel are in such cases very rarely if ever healthy.

It is certain that any circumstance which increases the propulsive action of the heart, must in so far conduce to aneurism; but that "in so far" goes very little way, unless the cardiac over-action be assisted by a *vis a fronte*; the force of the heart alone is unable to produce aneurism unless of a very diseased artery. This *vis a fronte* may be supplied by violent muscular efforts preventing capillary ingress; by over-tight clothing; by an infelicitous posture at the moment of exertion, suddenly occluding the artery; or perhaps by the impaction of an embolus.

MUSCULAR EFFORT.—The effect of over-exertion is well known; a simple act of this kind may produce the first distension or rupture of the middle coat, very slight perhaps, which repeated similar efforts may afterwards increase. The greater prevalence of aneurism in the male than in the female sex is the result of the hard muscular exertions more frequent among members of the former.

CONSTRICTION BY CLOTHING, ETC.—The effect of over-tight clothing is well exemplified by the prevalence of aneurism in the army. Mr. Myers has shown,² I think, conclusively that this prevalence is due not as is often asserted to syphilis, but to over-tight uniforms, especially to the stock; for syphilis and over-exertion are equally common in the navy—but aneurism is per 1000 men $13\frac{1}{2}$ times more frequent in the former than in the latter service.³ The effect of constriction on the neck or limbs must be a certain obstruction to the blood-stream along the vessels, and also a hindrance to elastic yielding of the arteries to different postures; so that sometimes the coats will be stretched lengthwise, perhaps to their uttermost, while a large wave expands them centrifugally.

The frequency of aneurism on the flexor side of much-used joints has been often noticed, and has been ascribed to the frequently produced sharp curve in the artery—obstructing the blood-current by the *vis a fronte* just mentioned. It must, however, be observed that this peculiarity is much more marked in the lower than in the upper limb, although the flexed posture is quite as often assumed in the latter as in the former; therefore position can hardly be the apparent cause, and a case about to be quoted tends to refute the theory, also often advanced as an addition to the posture hypothesis, of a greater muscular power and exertion of the lower limb. Popliteal aneurism is very frequently double, and not much less frequent is its recurrence, after cure on

¹ The word directly is used in the text because there is little doubt, as will be seen in the sequel, that excess of blood pressure may, by inducing certain forms of arterial disease, indirectly conduce to aneurism.

² Lancet, Feb. 20, 1869.

³ This subject will be further mentioned presently.

one side, in the other limb. The number of such cases to be found recorded in medical journals, is too large to quote; the occurrence has been ascribed to the mode of walking adopted by the patient, which, in order to spare the previously diseased side, throws additional exertion on the hitherto sound one, which therefore soon begins to suffer. The case related by Mr. Humphry, though it does not negative the possibility of such causation, at all events in part, shows very clearly that there is some other agent at work:—

CASE II.—The patient, a laborer, 37 years old, suffered from right popliteal aneurism. Mr. Humphry tied the superficial femoral artery with catgut; secondary bleeding occurred and recurred more than once, so that the man was very greatly reduced; the action of his heart was of course very weak; he was at rest in bed, and yet during a state and period which would appear most unfavorable to the production of any aneurism, a fresh one was developed in the popliteal space of the left limb.¹

The tendency to form double popliteal aneurisms does not depend upon an "aneurismal diathesis," nor on any general vascular degeneration. The persons who thus suffer do not, as a rule, engender the same disease on other vessels. There must, then, be some local condition—beyond mere frequency of flexion, muscular exertion, etc.—which renders this the most common form of all aneurisms, and which causes it to be so frequently double. Now the brachial artery at the elbow—quite as frequently bent as the popliteal at the knee—lies at some little distance from the bone, and is protected from it by considerable thickness of muscle, etc. Behind the knee, the vessel lies between the femoral condyles and in the popliteal notch of the tibia, close, therefore, to very hard structures, against which every pulse drives its front wall—a condition peculiarly likely to slowly damage its tunics. Mr. Barker showed, at the Pathological Society,² a remarkable instance of arterial disease, affecting both sides nearly symmetrically, and pointed out that wherever the vessels lay against hard bone, the affection was most marked. His inferences will be again referred to.

POSTURE.—Another occasional cause of aneurism is some infelicitous posture obstructing a vessel at the very moment of some strenuous exertion, as may be instanced by the following case:—

CASE III.—Mr. B. was a thoroughly sound and healthy man, save that he had had acute rheumatism 25 years before, which left no trouble save occasional attacks of rheumatic pains. No signs of vascular disease were to be detected. He was 40 years old, was non-syphilitic, unmarried, very temperate, accustomed to a fair amount of exercise, being a good cricketer, skater, and runner. He was giving a rather heavy child a ride on his foot, one knee being crossed over the other. He had no sense of something giving way, but felt suddenly that he must desist, and soon after was aware of weakness and a sense of fulness behind the knee-joint of the limb on which the child had sat. Two days afterwards he found a swelling at that place, of which at first he took no notice; but finding it, during the week, to increase rather rapidly, he consulted an excellent provincial surgeon, who pronounced it to be aneurism. I saw him a few days afterwards, and found the diagnosis to be quite correct, the tumor lying low in the popliteal space and having but thin walls.

In other cases, the position acts not so much by causing an obstruction in the lumen of the vessel as by binding it down and preventing it from yielding in the direction of limb-movement. For instance, in a bent limb, the vessel is shorter than in a straight one; but if it become somewhat fixed in that shortened posture by an old cicatrix, or by the pressure of clothing, bandage,

¹ British Medical Journal, 1876, vol. i. p. 599.

² Transactions, vol. xxviii. p. 86.

or strap, and then the joint be forcibly extended, the vessel cannot follow the movement, will become stretched beyond its proper degree of yielding, and will be very likely to have its middle coat torn across; that is to say, between the transverse fibres. A sudden increased heart-action at the moment when, by such stretching, the tube is rendered rigid and narrow, must assist in producing this result. A like curtailment of the yielding quality results occasionally from the healing of old inflammatory mischief or of abscess around a vessel; the cicatricial tissue, binding the outer coat to a more or less unyielding stricture, renders the artery liable to rupture, as those who have to deal with ankylosed joints are aware. That arteries, even when healthy, can bear only a certain amount of stretching, is proved by the experiment of Riche-rand, quoted by Hodgson,¹ and also by Holmes,² namely, the application in the dead subject of such hyperextension to the knee as shall cause the ligaments to crack; dissection will then very generally show that the two inner coats of the popliteal artery are entirely or partly torn through. Another illustration may be taken from certain mishaps that have occurred during overzealous attempts to reduce dislocations of the shoulder.³

EMBOLISM.—Sudden check to the arterial current through a limb by the impaction of an embolus, has been alleged as a cause of aneurism; but I think on insufficient evidence. Mr. Tufnell's case⁴ seems to me rather to show the difficulty of such occurrence. A man suffering from acute rheumatism developed suddenly a pulsating tumor in the popliteal space, which quickly subsided as collateral vessels became developed. After death, a very slight dilatation of the artery, plugged with fibrine, was found, proving that even when a systemic artery does enlarge from the lodgment of an embolus, only a transient dilatation—not an aneurism—is produced. Dr. Goodhart happened to have his finger on a rheumatic patient's pulse when it suddenly stopped. It is not recorded that any tumefaction was observed at the time. Some days after (period not recorded), the man died, when it was found that “the left brachial artery was considerably distended at the bifurcation, and, on opening it up, a white, creamy fluid escaped, like pus, and having the microscopic features of pus. The lumen of the vessel was dilated and its walls soft.”⁵ This suppurating vessel with softened walls can hardly be termed an aneurism. In the same volume of pathological records (page 98), are two cases, considered embolic by Mr. Bryant; the first was a case of ruptured femoral artery occurring in a rheumatic subject after a stumble, there being proof neither of aneurism nor of embolus; the second, also in a rheumatic subject, was a case of popliteal aneurism arising after some exertion. In Mr. Holmes's case,⁶ there was an ulnar aneurism and endocarditis (wart); there were, too, embolic clots in the kidney and spleen; but I cannot see any proof

¹ Diseases of Arteries, p. 64.

² System of Surgery, vol. iii. p. 418.

³ I have computed arterial elasticity thus: The subject, placed on the back, has a thick block under the shoulders, permitting the head to hang back as far as it will go (rigor mortis being eliminated). An assistant holds the points of a pair of compasses two inches apart on the bared common carotid; close to each point a pair of scissors is placed, the blades embracing the vessel; then at a given moment the vessel is severed simultaneously at the two points. The separated piece, which, while *in situ* in the posture described, measured two inches, now measures about an inch and a half. Thus:—

Sex.	Age.	Cause of death.	Piece measured.
Male	43	Violence	1½ inches.
“	30	“	1¾ “
Female	27	Phthisis	1¼ “
Male	51	Bronchitis	1¾ “

⁴ Dublin Quarterly Journal, May, 1853.

⁵ Pathological Transactions, vol. xxviii. p. 108.

⁶ System of Surgery, vol. iii. p. 423.

that the aneurism of the ulnar artery was due to embolus, or that any such substance ever got into that artery. I, of course, do not mean to deny that emboli become occasionally lodged in the systemic vessels, but I doubt if they can cause aneurism.¹

I do not think that stoppage of the blood stream, even if it were complete, could cause a healthy and uninjured artery to dilate rapidly into an aneurismal swelling. The dilatation, be it observed, must be rapid, for the strain upon the vessel becomes, as in Mr. Tufnell's case, very soon relieved by the development of collateral channels.

In the above paragraphs I have endeavored carefully to limit my remarks to systemic vessels—namely, those of the trunk and limbs—excluding visceral arteries; for the matter stands, undoubtedly, very differently in regard to such vessels. The thinly coated arteries of the brain, and in a less degree of the abdominal viscera, are much more easily affected by a centrifugal expansive force; they are, too, especially the former, less firmly supported by adjacent parts. For such reason, they are certainly not very infrequently the subject of embolic aneurism, as was first pointed out in the original and valuable paper of Dr. Kirkes. Numerous instances of cerebral apoplexy from burst aneurism, concurrent with fibrinous concretions from endocarditis, have been recorded,² while Drs. Ogle and Wilks have described cases of aneurism of the superior mesenteric artery with like association.³ Dr. Ponfick has written an excellent paper on the subject,⁴ in which he very clearly traces the connection between warty (verrucose) endocarditis and arterial embolus. He gives 6 cases, 4 of which were in the brain, 1 in a small branch of the splenic, 1 in a primary branch of the superior mesenteric artery. The singular prevalence of such aneurisms in the brain is, no doubt, in part accounted for by the curious tendency of floating solids to run up the left carotid; but this does not dispose of the abdominal cases, the fact being that emboli once beyond the aortic arch are just as likely to flow into the iliaes as into the visceral arteries. In the latter thin vessels, they may, if well placed, produce aneurism; in the former, they cause gangrene, or tendency to gangrene, or a peculiar tingling, painful condition of vessels beyond (see Case IV.), hardly distinguishable from subacute arteritis. It is singular that none of these phenomena were observed in the above cases of supposed embolic aneurism.

ATHEROMA AND OSSIFICATION.—But these extraneous causes of aneurism—occasional only, and some of them problematical—are less important than certain changes of the arterial coats, which so weaken them as to render their expansion or rupture almost inevitable, or at least extremely facile. This change, either atheroma or ossification, producing a weakening or rigidity of the arterial coats, has been ascribed to different pathological events, and located in various anatomical portions of the tunics. It would lead to little advantage were descriptions of all the views held by different writers here detailed. Rokitsansky,⁵ and, following him, Mr. Moore,⁶ consid-

¹ Mr. Holmes says, "that the objection often urged, viz., that aneurisms do not form on arteries suddenly obstructed by ligature, is an unsound one, since they do so form, although rarely." Here I must take leave to differ. When such occurrence takes place, it does so because the middle coat is divided. An impacted embolus can hardly so entirely block the vessel as a ligature, nor does it sever the tunics. For some other opinions I must refer to the volume of the *Pathological Transactions* above quoted.

² Holmes, Gowers, Goodhart, Ogle: *Pathological Transactions*, vol. xii. p. 61; vol. xxviii. p. 107; vol. xviii. Wilks, *Morbid Anatomy*. Gull, *Guy's Hosp. Reports*, 3d ser. vol. v.

³ *Pathol. Trans.*, vol. viii. p. 168, and vol. xi. p. 44.

⁴ Virchow's *Archiv*, Bd. lviii. S. 546.

⁵ Ueber einige der wichtigsten Krankheiten der Arterien, S. 2.

⁶ Holmes's *System of Surgery*, vol. iii. p. 393.

ered a deposit from the blood (Auflagerung) to be the initial step. But since the appearance of the Cellular Pathology of Virchow, whose views are followed by Niemeyer¹ and Moxon,² it appears that the inflammatory nature of both atheroma and ossification must be accepted; the Berlin Professor's excellent account of the condition, traced from its initial to its terminal phases, can hardly be improved.

PERI-ARTERITIS.—Disease of the outer arterial tunic, *peri-arteritis*, is of small importance; it is nearly always consecutive to, and directly dependent upon, inflammation of the neighboring tissues, as in suppurative or phlegmonous inflammation. The possibility of abscess opening into arteries is undoubted, and will again be mentioned, while the diminution of extensibility which may arise from adhesion of the outer coat to surrounding inflammatory thickenings, has together with its effects been already discussed.

The middle coat generally participates in the diseases of both the outer and the inner tunic, and we know nothing of any active disease affecting this structure independently. But we do know a good deal of a fatty degeneration which not unfrequently attacks, and is for some time confined to, the middle coat. It assumes the simple form of such degeneration, as we see it in the muscles of the heart, in the articular cartilages, or other cellular organs: namely, a massing of oil molecules, at first within the lumen of, then also around, the cell. It is this condition which gives rise to long and but little accentuated fusiform aneurisms, or to aneurismal dilatations, and is, in all probability, the constant cause of multiplicity of aneurisms—the aneurismal diathesis. Moreover, irrepressible, consecutive and secondary hemorrhages have very commonly a similar origin.

ENDARTERITIS is, however, the most important of all the arterial diseases with which we have to do; it may be either acute or chronic, though acute endarteritis is certainly very rare.³

I have never seen an idiopathic case of the malady in an open artery, but several instances of plugging and subsequent endarteritis have come under my notice. Of traumatic endarteritis I can give the following very striking example:—

CASE IV.—R. W. was a man for whom I had tied the right carotid and subclavian arteries. Twenty-six days afterwards he complained of a burning and aching pain along the course of the brachial, ulnar, and radial vessels of that side. The temperature had varied from 97° to 102° Fahr., morning and evening. His diet had, till six days previous, been dry and restricted, but was at this time an ordinary full diet. He had no pulse either at the wrist, or in the brachial or lower part of the axillary artery. On the morning of the 9th of September, the day in question, he complained of peculiar, hot, tingling pain from the shoulder to the hand, along the course of the arteries, which felt hard

¹ Lehrbuch der speciellen Pathologie und Therapie, 9te Auflage, Bd. i. S. 357.

² Guy's Hospital Reports, 3d series, vol. xvi. p. 431 *et seq.*

³ Some surgical writers describe acute or subacute arteritis, its symptoms and effects, in a manner which facts, as far as we know them, do not authorize. The "plastic or embolic arteritis" described by Erichsen, and for proof of the existence of which he refers to the effects of pressure, as by a tumor, or the action of a ligature, never arises *sua sponte* in a previously healthy artery, though plugging by an embolus from the heart, or occlusion by pressure, will cause coagula to form, and subsequently to become adherent to the now disused vessel. The inner coats of an artery tied with silk, are divided, and the wound throws out an adhesive material; but there is no reason to believe that any part of an acting and still patent artery can become gradually occluded by the solidification of fibrine thrown out from its own inner surface. Neither clinical nor pathological observation can furnish a single instance of such an occurrence. Mr. Erichsen, in his two short paragraphs concerning plastic endarteritis (Science and Art of Surgery, vol. ii. pp. 1-3), appears to me to have overlooked the presence of the intra-vascular wound in tied arteries, and there is therefore a *non-sequitur* involved in his second proposition.

and cord-like, and were very tender. That evening his temperature *decreased* to 96.4° , and afterwards remained normal. A slight stimulation of the skin with ammonia liniment was followed in three days by relief. On the 23d it was noted (I being absent) that the axillary and brachial arteries were swollen, hard, and excessively tender; their enlargement was even visible; they were painted with tincture of iodine; the pain and swelling disappeared in three days.

As other conditions more grave than the localized arteritis were probably affecting the temperature, little stress can be laid on the constitutional symptoms; but it is remarkable that the thermometer declined to below the normal standard on the evening when the above symptoms were complained of. It is also to be observed that this occurrence took place in empty vessels, and perhaps might be the natural result of nature's successful effort to close, by inflammation or adhesion, useless tubes. A slighter instance, following in all probability the impaction of an embolus, also occurred in my practice:—

CASE V.—Edward E., aged 46, stationer, was admitted under my care into Charing Cross Hospital, December 19, 1880. The man's father died of heart disease; he himself has always led a regular and temperate life, and has never had syphilis. Twelve years ago he had "rheumatic gout" (probably a smart attack of subacute rheumatism); he has of late suffered from palpitation of the heart. On December 11, he gave a lad a back-handed box on the ear. Half an hour afterwards, while using a small plane, he noticed that his fingers became contracted and his hand weak; afterwards the arm felt very tired, with tingling and aching. Next day, on washing in cold water, the 3d and 4th fingers "went dead" (the weather at the time was unusually mild). The sense of weakness and the aching increased slightly up to the time of admission. No pyrexia; hand cold. December 17.—The beat of the right radial pulse was barely perceptible, that of the left one normal; the man complained of pain and tingling from the elbow to the axilla, along the course of the vessels and nerves; a cord-like enlargement of the artery could here be distinguished. Dec. 18.—The pain up the inner side of the arm and along the front of the forearm was, he says, considerable during the night; to-day there was no pulse at all in the right radial; a slight hypnotic was ordered, and fomentations. Dec. 19.—I saw the patient for the first time and examined him very carefully. The arm being wrapped in cotton-wool was warm nearly to the elbow, a little lower in front than behind; beyond this boundary the limb became gradually cooler; the hand was cold. Both the radial and ulnar arteries were rather hard to the touch; neither pulsated; above the elbow, a round, not very firm, cord could be felt in the position of the brachial artery, not pulsating, but full; pain as well as tenderness was here complained of. The heart's action was very irregular (Dr. Bruce's report as to the heart is given at the end of the case), but I could detect no murmur; perhaps a little enlargement. There was no elevation of temperature; urine, digestion, appetite, etc., were perfectly normal; but the man was of nervous temperament, had read some medical books, used medical terms, and complained of several pains, the existence of which seemed doubtful, though some about the right arm may very likely have been owing to dilating collateral vessels. Dec. 22.—Still continues in much the same state; slept badly, from pain in the testicles. January 4.—Pain and tenderness had gradually diminished; he said the arm still felt weak, and a little numb; the radial, ulnar, and brachial pulse was absent, the brachial artery feeling like a hard cord (a cedar-pencil), movable beneath the skin.

Dr. Mitchell Bruce has been kind enough to give me the following report of the state of Edward E.'s heart. Pulsation very irregular, second sound weak and muffled, some hypertrophy. A distinct murmur at base and apex, coincident with both first and second sounds, indicative of aortic incompetence due in all probability to warty endocarditis.

Chronic endarteritis is one of the most common diseases to which the human subject, after middle life, is prone; the disease itself presents no symptom by which its presence can be inferred: it is known chiefly by its effects. It is most common at the commencement of the aorta, and next in the cerebral branches; but it may arise in any artery, and indeed, in far advanced cases,

every vessel of the body carrying red blood may be affected; those which carry venous blood, and the pulmonary veins, are almost entirely exempt.

The results of the inflammation, characterized by hyperplasia and proliferation in the deeper layer of the inner coat, are two. First, what in the commencement appears like a mere thickening of the tunic, which adheres with unusual tenacity to the underlying structure. This thickened patch, though still covered by epithelium, is somewhat duller, of a more opaque, yellowish-white than the rest of the surface, and elevated above it; in other words, it encroaches on the vascular area. In a later phase of its development, this patch becomes still harder and firmer, semi-cartilaginous in consistence, and puckered on its inner surface, while encroaching more and more on the middle coat whose whole thickness it may ultimately occupy. But it is to be observed that the encroachment does not, at all events till a late stage, diminish the calibre of the vessel, which up to a late phase of the disease is greater than normal, while its length also is increased. The microscope shows this indurated and thickened spot to consist of ramified spindle-cells, intermixed with firm and apparently thickened bands of fibrous tissue continuous on one side or the other with the healthy structure of the surrounding tunic. The elements, cellular as well as fibrous, are at this stage healthy; but sometimes fat globules are interspersed among them.

Another less frequent form is often present on the same artery with the denser thickening; it is distinguished by its jelly-like consistence and pale, pink color; it is more superficial in its origin than the form first described, but still lies beneath the epithelial lining of the vessel, under which it may be pushed a little way hither and thither; it may occur in small patches, or may occupy larger portions of the tissue. The new formation, under the microscope, is seen to consist of oat-shaped and spindle-shaped cells running in lines crossing each other in all directions, and inclosing an amorphous ground substance, studded often with bare nuclei; in fact, it bears the strongest resemblance to granulation tissue.

To the unassisted eye, both these conditions produce on the inner surface of the artery wart-like or hob-nail elevations of various sizes, from that of a mustard-seed to that of a horse-bean, or even larger; these are somewhat flattened towards the area of the vessel, ovoid rather than round, with the long axis in the circumference, or else quite irregular, and in this phase covered by epithelium. Between any two such elevations, especially of the former sort, the inner coat is often puckered, while the middle appears thinned and weak.

The fate of these two varieties is somewhat different, or at least is often different. From my own investigations, I have strong grounds for believing that the latter form not unfrequently hardens and forms a sort of inflammatory or cicatricial tissue, which may then undergo the same ultimate changes as the former species, or may, like all tissue resulting from granulations, shorten and contract, thus producing those puckerings and indentations so frequent on the inner surfaces of large arteries. But occasionally the granulation, if I may so term it, having invaded the deeper layer of the inner, as also a variable thickness of the middle tunic, and having undergone, first on its inner face, a puro-fatty change, eats through the epithelial pellicle, and falls little by little into the blood stream, leaving behind a usually small ulcer, leading into a somewhat larger cavity of a depth equivalent to the amount of its invasion.

The more frequent result of the inflammation—the dense, yellow, semi-cartilaginous thickening—may remain passive a very long time. Large vessels, chiefly the aorta, may be so studded with the projections thus produced that the name *endarteritis deformans*, given by Virchow, is by no means a misnomer.

It is not uncommon to see in the post-mortem room such an aorta, puckered, grooved, and roughened, so that few patches of the surface remain normal; yet no aneurism may be present, although the channel is somewhat widened. If the disease affect some more superficial vessel, the lengthening thereby produced is marked by the undulations and zigzag course of the artery. Nevertheless, the tendency of this new formation is towards degeneration, fatty or calcareous. Both these begin in the deeper layers of the tissue; the former by the gradual accumulation of oil-globules around the nuclei of the proliferating cell, whose walls give way, so that the oil lies among the fibres, which then also degenerate; cholesterine crystals are deposited, and when the process is complete, the whole mass becomes a bag of gruel-like or porridge-like substance—the condition indicated by the word *atheroma*. If this burst into the vessel through the epithelial covering, it forms the “*atheromatous ulcer*,” which not unfrequently heals, leaving a cicatricial loss of substance. The calcification resulting from the deposit of minute molecules of lime salts in the deeper parts of the firm new tissue, proceeds gradually towards the surface; it sometimes converts the whole patch into lime; sometimes it is accompanied by fatty degeneration of the more superficial parts. In such large vessels as the aorta and its immediate branches, larger or smaller specks only will have become bony; vessels of less calibre may be converted into rigid, bone-like tubes. Occasionally a patch, more especially if fatty degeneration have helped it on its course, may break through the epithelial lining, and lie bare to the blood; sometimes the current getting under such a piece will turn it sideways to the vessel, so that its edge projects into the stream and may gather a clump of fibrine around it, or the whole piece may be washed bodily away from the place of its formation, to be entangled and to form an embolus somewhere in a narrower part of the circulation, while the spot whence it came remains as an ulcer and as a weakened part of the artery.

The effects upon vessels of these different results of inflammation, in their various stages, are these:—

The soft gelatinous growth may, indeed often does, rapidly produce a loss of substance in the vascular walls; if it follow this course, the especial weakness which may give rise to aneurism is produced, and such disease is imminent according to the size of the spot; it is probable that dissecting aneurisms arise in places thus affected; if, on the other hand, the granulations harden into new tissue, the artery at that spot is strengthened, but with loss of elasticity.

The semi-cartilaginous thickening, while it remains hard and dense, also strengthens that particular point of the artery, but likewise with loss of elasticity. When the new material softens, that part of the vessel is weakened and apt for dilatation.

Since the middle coat around these spots of thickening is generally more or less in a state of fatty degeneration, and since the parts, altered as above described, are inelastic, it follows that unusual strain falls upon the portions which have not become hard and rigid; moreover, the roughening of the interior of the artery, obstructing the blood-current, increases the pressure on those parts of the vascular walls which are not the seat of the thickening. Calcification hardens and protects the vessel against dilatation at the converted spot, but its rigidity increases the strain on such parts of the walls as are still dilatable. If either or all of these forms of thickening and encroachment on the arterial walls occur near the heart, as in the first part of the aorta, such an impediment to the course of the circulation is produced that hypertrophy of the left ventricle usually follows, thus increasing the tendency to aneurism by adding force to the blood-current.

We have yet to consider what primary cause can originate the chronic endarteritis leading to these changes. It must be observed that it is not a disease of early life; we do not meet with it before the age of thirty, seldom before that of forty-five. Congenital or acquired syphilis, tuberculosis, rheumatism, alcoholism, do not seem capable of causing during youth the endarteritis which ends in atheromatous thickening.¹ Another point to be observed is the absence, with very rare exceptions, of atheromatous thickening in the venous system, a fact which some writers have regarded as supporting the view that the malady originated in a deposit from arterial blood. But it should be recollected that the pulmonary veins which contain red blood are at least as free from atheroma as the arteries of like name which contain dark blood; also it should be remarked that the tunics of the venous system are differently constituted; nor are they exposed to the same amount of pressure from within.

SYPHILIS.—A certain number of writers, chiefly military surgeons, consider atheroma and aneurism essentially syphilitic, and this view is strongly upheld by Dr. Aitken,² who says: "I believe that a large proportion of cases of inflammation of the large vessels ending in atheroma are of syphilitic origin," and doubtless some records of military surgery seem at first sight to support this idea. Thus Mr. Welch³ relates that of thirty-four cases of aneurism in the army, seventeen occurred in syphilitic soldiers; but such numbers prove nothing, unless it be known what proportion of the regiments from which these men came were similarly affected. Mr. Lawson, in his statistics,⁴ shows that aneurism is more frequent in the military than in the civil population; but here again the other circumstances of military life are not known or noticed. Mr. Myers⁵ has very ably sifted the statistic numbers, and the inference drawn from them, thus: Syphilis is about equally prevalent in the army and in the navy, but for aneurism the numbers for four years are:—

	Army strength.	Aneurism per 1000.	Navy strength.	Aneurism per 1000.
1862	49,332	.28	58,870	.11
1863	44,291	.47	54,090	.05
1864	40,539	.37	53,000	.18
1865	42,228	.35	51,210	.09

Both sets of men are subject to much the same influences of climate—both have to undergo considerable bodily exertion. But the sailor wears a loose overshirt, with no constriction around the neck; the soldier a tightly-fitting coat with a tight collar, obstructing circulation in the axillaries and carotids. The soldier suffers especially from aortic aneurism.

Moreover, it is to be observed that we frequently encounter in the post-mortem room the bodies of children or young persons in an advanced condition of syphilis, whose viscera may be more or less studded with gunmata, but atheroma is quite as rare with them as with healthy individuals, nor does it begin at an earlier period of life in the one set than in the other. Four cases

¹ It should be here remarked that certain aneurisms are marked with these thickenings, even though in comparatively youthful subjects; but the stretching or tearing that the vascular tunics must, in order to permit of aneurism, undergo is, in all probability, the direct cause of localized endarteritis, since when we find on an aneurism, especially if the patient be young, one or two such nodules, while the rest of the vascular system is healthy, we are not to conclude that the atheroma produced the aneurism; the sequence of causality is probably exactly the reverse.

² Science and Practice of Medicine, vol. ii. p. 630.

³ Med.-Chirurg. Trans., vol. lix. p. 59.

⁴ Transactions of Army Medical Department, 1866.

⁵ Pathological Transactions, vol. xx. p. 134.

of very early aneurism are recorded,¹ but not one of the patients is described as having been affected by syphilis. In ordinary hospital and civil practice, we find that, while aneurism is undoubtedly less common in females than in males, syphilis offers no such great sexual disparity; nor have I found that prostitutes are peculiarly liable to atheroma or to aneurism—certainly not at all more so than might be expected, seeing that persons of that class are usually somewhat intemperate, and exposed to rough usage from blows, &c.

If we examine the records of the London Pathological Society, we find that during the 10 years, from 1871 to 1880 inclusive, 68 cases of aneurism were recorded. Of these—

In 23 syphilis is not mentioned,
 “ 35 “ is stated to have been absent,
 “ 8 “ is stated to have been acquired,
 1 patient is said to have had soft chancre,
 1 case is mentioned as uncertain.

In those of the first class, the history of all illnesses being given, the non-mention of syphilis is significant. The patients are described as having been healthy in 6 cases; as drunkards in 3; the aneurism is ascribed to sprain in 4.

In the histories of the second class, drink is recorded in 4; acute rheumatism (3 times in 1 patient) in 3; blows or sprains in 5. In the case of the patient to whom soft chancre is ascribed, no secondary marks were recorded during life or after death. The one whose infection is called uncertain, was a confirmed drunkard. Of the 8 who are said to have had syphilis, 1 had chancre as a lad and died at 29, no secondary marks being recorded, a drunkard with cirrhosis of the liver; 1 had chancre 16 years before, no secondaries recorded; 1 had scars of buboes, absence of secondaries mentioned; 1 is stated to have had secondary and tertiary symptoms; 1 is recorded by Dr. Mohammed, in the volume for 1878, as having exhibited in the post-mortem room secondary lesions.

Now I am aware of the little weight that can as a rule be attached to negative evidence; but it can hardly be supposed that in 59 cases out of 68, syphilitic degenerations of internal organs would, if present, be overlooked, save in a single instance. This negative testimony shows, at all events, the absence of positive evidence. Yet it is not my intention to deny the existence of a syphilitic arterial degeneration—indeed it is certain that such a thing exists. Dr. Wilks² was, I believe, the first to point out that such changes probably take place, but he shows his great pathological insight by expressly stating that, “If it be true that the bloodvessels are liable to be affected with the syphilitic taint, it will probably be found that the change is not of the atheromatous kind, but rather of the fibrous character exemplified by the thickening of the coats of the vessel, and the proportional diminution of their calibre.” Dr. Clifford Allbutt³ points out that syphilitic arterial thickening is much more rapid than atheroma, and Dr. Moxon⁴ also notes many points of difference. I must also point to the fact that while atheroma has its favorite seat in the aorta and large vessels, syphilitic arterial disease affects smaller branches, chiefly those not larger than the temporal over the squamous bone, or the ulnar in the palm—rarely vessels as big as the radial at the wrist; that it has a marked proclivity for the cerebral branches of the internal carotid; that, unlike atheroma, it does not, in the initial stage, enlarge the lumen of the vessel, and at no stage increases its length so as to make it wavy; its first attack is closer to the endothelium, is, in fact, in the deeper layers of that

¹ Hutchinson, *Path. Trans.*, 1854; Armitage, *ibid.*, 1858; Syme, *Edinburgh Monthly*, 1844; Smith, *British Medical Journal*, vol. i., 1867.

² *Guy's Hospital Reports*, 1863, p. 45.

³ *St. George's Hospital Reports*, vol. iii. p. 55.

⁴ *Op. cit.*

structure—its tendency is towards obliteration of the vessel by encroachment on its lumen. As to its microscopical characters, I would chiefly refer to the presence of giant cells, with a large quantity of round cells,¹ and to the after striation and fibrillation of the syphilitic growths. Indeed, syphilis as it affects these vessels is in nearly every point, if carefully examined microscopically, macroscopically, and clinically, different from atheroma.

I think, therefore, we must conclude that there is no clinical or anatomical evidence to show that systemic vessels, large enough to permit the formation of an important aneurism, are ever the subject of syphilitic affection. To refute the somewhat widely accepted hypothesis that aneurism is of syphilitic origin, would require a vast number of negations, each one of which might be answered by asserting that the examination had not been sufficiently careful or scientific. But it must be pointed out that on him who makes the assertion, lies the burden of its proof, or at least of its support with some array of sufficiently sifted facts, such as are at present entirely wanting.²

RHEUMATISM occupies a very different ground. Inflammation of parts of the circulatory system is a well known accompaniment of that condition, and a large number of aneurismal cases have suffered from acute, others from subacute rheumatism. It certainly appears likely that a disease which produces endocarditis may also cause endarteritis.

ALCOHOLISM has, I believe from my own observations, great influence on the production of atheroma; especially does the drinking of raw or slightly diluted spirits tend to this condition; probably the circulation of alcohol and fusel oil in the vessels irritates the inner coats. The frequency of aneurism in Ireland, where this unfortunate habit prevails, may to some extent support this view. Excess in more largely diluted spirits leads, as we know, to non-inflammatory fatty degenerations of various tissues, among them to that condition of the middle coat mentioned a few pages ago, on which the aneurismal diathesis depends.

I believe, though I cannot prove, that aneurism, when due to a systemic condition at all, is more frequently owing to the abuse of alcohol, or to rheumatism, or to both, than to any other cause. The frequency of aneurism in England, so much greater than in France or Germany, may be owing in part to the dampness of the climate, and in part to the unfortunate national love of strong liquor. It must be added that in both the above continental states the tendency to aneurism is greatly increasing.

STRUCTURE OF AN ANEURISM.

CONTENTS.—The contents of an aneurismal sac always consist of blood; but this blood is not always in the same condition, for it may be entirely fluid, as, indeed, is generally the case in fusiform aneurisms; or, it may be loosely coagulated, barely consistent, like the ordinary clot formed of blood poured from a wound—this sort of semi-solidified coagulum was named by Broca "*passive clot*;" or, again, the cavity may be lined partially or throughout by firm, buff-colored fibrin, from which the globules have been extruded. Most sacculated aneurisms are thus, as it were, padded—at least in those

¹ Heubner, *Die luetische Erkrankung der Hirnarterien*, 1874, S. 127. See also, Lanceraux, *Traité historique et pratique de la Syphilis*; Langhaus, in *Virchow's Archiv*, Bd. xxxvi., S. 187, and a host of others.

² Many morbid anatomists assume syphilis from the presence of atheroma, and then formulate the contention that atheroma is syphilitic.

parts which lie out of the most rapid current; hence, those with small mouths have *cæteris paribus* the most of such lining, which, being deposited from the blood by successive acts of solidification,¹ is laminated and marked by concentric lines. Broca called this material "*active clot*." We shall see, by and by, that aneurisms may by the accumulation of such coagulum be spontaneously cured; that upon the induction of such accumulation our successful treatment is founded; and that, in certain cases, the choice of methods is to be guided by an estimate of the quantity of such clot which nature has already deposited in the sac. Moreover, it is noteworthy that a lining of firm, resilient fibrin acts against the force of the blood as a species of buffer, protecting the proper wall of the tumor, and preventing, according to its thickness, further distension and rupture. All aneurisms which are thus lined, and in so far protected, progress—if nothing modify the conditions—more slowly than those in which no active clot is formed.

THE SAC OF AN ANEURISM may consist entirely of the arterial coats, all three being present in the fusiform variety, unless it be unusually large, while in the sacculated, unless merely incipient, both the inner and middle coats are deficient throughout a large part of the tumor. In many cases, however, all three coats have over a certain extent given way. The sac is then formed in part by laminated fibrin, in part by surrounding structures. Many thoracic aneurisms, which press against the parietes of the cavity, have for part of their sac the spine, the sternum, the ribs, or their cartilages. The stretched arterial tunics which enter into the formation of the sac are, in large aneurisms, generally atheromatous, calcareous, or both. Sometimes even patches of true bone are found, but this is rare.

SYMPTOMS OF ANEURISM.

The *symptoms of aneurism* are some of them intrinsic, or direct; others extrinsic, or indirect.

Intrinsic Symptoms are inherent qualities of the aneurism itself. If disease were strictly logical, we might describe them as necessary and integral parts of the malady, but since the body is not an exact machine, one or another of them may be absent.

Extrinsic Symptoms are due to the influence of the aneurism on surrounding parts, and are chiefly referable to the effects of mechanical pressure. They vary, therefore, with the function of the part compressed. In certain localities the intrinsic signs are not to be detected, or are greatly obscured by inclusion of the tumor within the more or less resistant walls of some cavity. In such cases the extrinsic signs may enable the surgeon to infer the presence of aneurism.²

PULSATION.—The most marked and characteristic sign of an aneurism, situated within reach of palpation, is the presence in the course of an artery of a pulsatile tumor. If the form of the swelling be elongated, and the throb extend over a narrowing space and with diminishing force, for a considerable distance up and down the limb, the aneurism is of the fusiform variety; if the tumor be round or oval, and clearly defined from its surroundings, while

¹ The theory that this clot is a secretion from the vessels is sufficiently disproved by observing that in most cases it barely adheres to the inner wall of the sac.

² Until lately, internal aneurisms, save a few abdominal cases, interested only the physician; but recent advances, due chiefly to Dr. Cockle, Mr. Heath, Mr. Holmes, and myself, have placed thoracic aneurism within the pale of surgical treatment.

the separate beat of the artery immediately above and below cannot be verified, the sacculated form of aneurism may be suspected. I say suspected, because every tumor which pulsates is not an aneurism; the pulsation must be of that peculiar quality which we term expansile—that is to say, when the swelling is grasped in the fingers of one or both hands, the beat must seem to drive them apart; it must not merely lift the hand as by a wave propelled from below, but the swelling must be felt to dilate and enlarge with every beat of the heart. If the aneurism be so situated that the artery above it can be compressed, pulsation ceases when such pressure is exercised, and the tumor becomes smaller and flaccid—may, indeed, almost entirely disappear; by manipulation, unless it contain a large quantity of clot, the sac may be still further emptied.¹ The surgeon should now mark well the size of the enlargement, and let the pressure above be suddenly removed, when he will see or feel the more or less abrupt restoration of size and refilling of the sac. In some cases, that is, when the aneurism has a large mouth, this enlargement is very sudden—with one beat of the heart the whole sac is filled as by a leap or plunge; when the mouth is small, several pulsations, perfectly visible and distinct, are required to fill the tumor; but I would draw especial attention to the fact that the initial pulsations are as strong, or very nearly so, as the usual throbs of the tumor. They do not begin weak and increase slowly. Sometimes in aneurisms whose walls are thin and are not thickly lined by clot, compression on the vessel below will cause a certain slight, and almost momentary, enlargement. This symptom, when present, is a useful aid to diagnosis—its absence predicates nothing as to the nature of the malady. Generally, the vessels beyond an aneurism beat less forcibly than in the normal state; less forcibly, for instance, than those of the other limb. When vessels leading to the arm, or even to the head, are affected, this symptom is more easily appreciated than when those leading to the lower limbs are involved, since the arteries are better placed for feeling the pulse; we may, in the case of the arm, gain greater accuracy by the employment of the sphygmograph.

BRUIT.—A symptom which is often present, though frequently absent, is a sound at each pulsation. It varies greatly in quality and character, being in some cases a mere thrill or purr, in others an almost flute-like noise, a creak, a rasping or a sawing sound. It appears that its characters, and even its existence, depend upon the size, shape, and situation of the sac's mouth, and perhaps also in part on the nature of the surroundings. Abdominal and thoracic aneurisms, for instance, are rarely accompanied by any bruit.²

This sound, when present, is very conclusive evidence of the nature of the disease,³ but its absence in no way negatives the presence of an aneurism. I have known several aneurisms which, during some part of their progress, emitted well-marked sounds, and at other stages were quite noiseless; as also many that have been silent throughout. These intrinsic symptoms of aneurism can be verified with ease when the disease is external, but if it be internal many of them cannot be made out until the tumor has attained a considerable size—more or less, according to situation—that is to say, until it has to a certain degree approached the parietes. A tumor, for instance, on the third part

¹ This method of research should be very cautiously, if at all, employed, since the clot which may have formed is liable to displacement, when its beneficial action would be prevented, and perhaps danger of embolism evoked.

² A peculiarity of sound to be noted hereafter is very generally observable when the disease is intrathoracic—viz., the second sound of the heart is abnormally loud over the tumor, while no such exaggeration is perceptible over the heart itself.

³ A few non-aneurismal tumors occasionally emit a distinct bruit, as will be noted immediately.

of the aortic arch, growing forward, must be very big before it can be felt to pulsate on the front of the chest, while an aneurism of the first part of the aorta, increasing in the same direction, will pulsate through the costal cartilages very much earlier. So, also, an aneurism arising between the pillars of the diaphragm, cannot be detected by clearly-marked pulsation as early as one on a level with the third or fourth lumbar vertebra. Nor can at any time the tumor be grasped or manipulated, so as to verify the expansile beat above described. The existence of certain aneurisms, especially within the thorax, may often be suspected, and sometimes clearly diagnosed by a correlation of certain symptoms, effects of pressure, etc., before any pulsation can be distinctly verified. But to this subject we must return.

PRESSURE SYMPTOMS.—The symptoms which I have classed together under the name extrinsic, are those which are produced on the neighboring parts by pressure, and it seems that in this pressure there is something peculiar, as we do not see the same intense effects produced by other tumors; probably the special quality lies in the beat, that is to say, in the intermittent nature of the force. We find, therefore, that when an aneurism impinges upon bone, it effects its absorption sometimes with surprising rapidity; it also displaces and absorbs solid soft tissues very quickly; if it come in contact with nerves, it flattens them out and causes troubles according to their function; and if in apposition with a tube, occlusion takes place: thus, for instance, veins, trachea, bronchi, œsophagus, and ducts are closed by the growth. Hence it will be evident that the pressure symptoms of aneurism must vary with the locality; many of them will require careful study in connection with aneurisms of special arteries, but we may here describe the more common of such symptoms as they occur in the limbs.

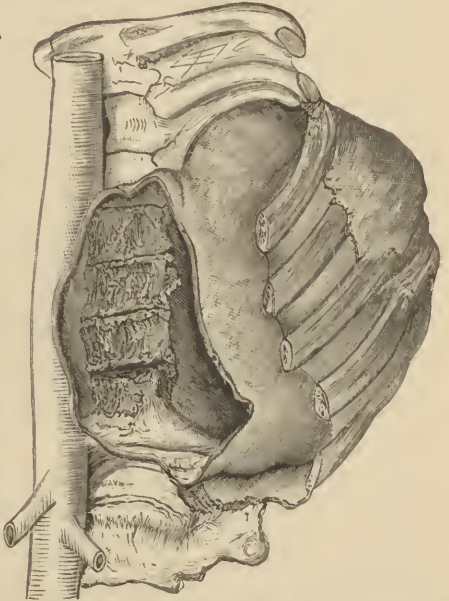
Enlargement of veins and œdema below the seat of disease are common in aneurisms of such arteries as lie close to veins. Hence different localities exhibit these symptoms variously as to their time of appearance and their degree; not only so, but aneurism of an artery will in one case be accompanied by early and strongly marked œdema, while in another case the symptom is of later occurrence and never becomes prominent. For instance, innominate aneurism may be primarily manifested by œdema of the left supraclavicular region and left arm—swelling of the right side being late or never occurring; in other cases, the œdema will manifest itself first and chiefly on the right side. Certain subclavian aneurisms will be chiefly evidenced by swelling of the same side of the neck, and, if on the right side, by teasing cough or aphonia, while the first symptom in other cases is agonizing, remittent pain running down the arm. When the disease affects either common or external iliac, or common femoral, œdema of the leg and thigh is very nearly always an early and well-marked symptom, while aneurism of the aorta, just above its bifurcation, may produce the same result in both lower extremities. Œdema, in any of these diseases, may be the first thing which attracts the attention of the patient. Thus in 1867, a man came to me complaining of nothing but a swelled leg and thigh, which he said felt heavy and stiff, but were not painful. He had no idea whatever that he had any severe malady, attributing the swelling to a severe catarrh which he had lately caught; I found, just beneath Poupart's ligament, an aneurism about the size of a hen's egg.

When a nerve is so placed as to cross or lie upon the tumor, it usually becomes flattened and thin; the pressure is rarely sufficient to entirely close the tubules, but often produces *numbness*, and some degree of *anæsthesia*; the sense of *weakness*, so often mentioned by patients, is doubtless often due to similar mechanical effects on the motor portions of the nerve. This partial closure and stretching of the cords is accompanied by intense shooting and

stabbing *pains*, which may first of all call the patient's, and so the surgeon's attention to the part. Such early, and, if I may so call it, primary manifestation of pain, is most common in aneurism of the last part of the subclavian and first of the axillary artery; sometimes it is early in popliteal aneurism—when, namely, the tumor springs from the superficial wall of the artery and grows backwards. The *motor function* of nerves may also be greatly affected, or indeed altogether destroyed; this is most strongly exemplified, as we shall see in the sequel, in certain aneurisms of the upper part of the thorax and lower part of the neck, which paralyze partially or totally a vocal cord.

We have seen that one of the most remarkable consequences of aneurism is the production by its pressure of rapid *absorption*, usually without suppuration, of bone and of cartilages. Erosion of the vertebrae is a common result of aneurism of the descending aorta; the outer case, that is, the harder part of the bone resists the rodent action for a certain time, but when this is once broken through, absorption is very quick; aneurisms have more than once, after eating away the vertebral body and the adjacent intervertebral substance, burst into the spinal canal. But most limb-bones, being more dense, are with more difficulty attacked; hence, in such a malady as subclavian or popliteal aneurism, the clavicle or femur is less often found excavated. Sternum, ribs, and costal cartilages are frequently eroded over the space on which a thoracic aneurism is pressing. The pressure and caries produce pains which are often very severe, and of a character which must be distinguished from those of nerve pressure; they are generally more distinctly localized, and are burning and aching.

Fig. 537.



Aneurism of the thoracic aorta, eroding vertebrae and ribs; front of sac removed to show vertebral bodies. (From a preparation in Charing Cross Hospital Museum.)

DIFFERENTIAL DIAGNOSIS.

Both intrinsic and extrinsic symptoms of aneurism have a certain margin of ambiguity which care in examination must eliminate. I would most especially insist on this element of care. Certain fortunately rare cases, even of limb aneurism, present difficulties which may baffle the most searching and skilful investigation; but by far, by very far, the larger number of disastrous mistakes which have been made in dealing with aneurisms, have been due to insufficient caution, as when, for instance, a surgeon, with misplaced self-confidence, plunges his knife into a painful, fluctuating, and apparently to his hasty palpation, a nonpulsatile tumor, even though it may lie close to a large artery. Care and caution in such cases are the points upon which I would lay the greatest stress; no swelling in the course of, or over, a large artery ought to be opened without a previous thorough and searching investigation.

The causes of error fall naturally into two categories, for there are,

- I. *Pulsatile tumors that are not aneurisms*, and
- II. *Aneurisms that are not pulsatile*.

I. PULSATILE TUMORS THAT ARE NOT ANEURISMS.—Any tumor, fluid or solid, if placed immediately over a large artery, may have pulsation communicated to it. An *abscess*, well encysted and firmly bound down by fascia upon such a vessel, may pulsate in a very deceptive manner, and many mistakes which have been made under such circumstances might be collected. They appear to have arisen less frequently from the inherent difficulties of the case than from the habit of accepting one or two symptoms as conclusive in diagnosis. The presence of inflammation, the appearance of pointing, the absence of pulsation, do not, even when taken altogether, prove a swelling to be an abscess. As, for instance, in the case which Pirogoff records,¹ with a frankness that does him honor: He was, on his return from a long and fatiguing journey, called to a man who was in severe pain from an inflammation, apparently a suppurating phlegmon, of the leg; immediate relief from his suffering was the patient's only desire. The case seemed to the overtired Pirogoff perfectly clear; he plunged a scalpel into the swelling, and was informed of his error by a gush of arterial blood. Richet² was on the point of opening what seemed to him an axillary abscess, when he fortunately felt a thrill, and on further examination detected bruit. The case was one of axillary aneurism. Inflamed aneurisms, when more deeply placed, are more difficult of diagnosis; as, for instance, in the case of Bergmann, who opened what appeared to be a "phlegmonous angina." No sudden escape of blood ensued, but the patient died of asphyxia, when the disease was found to be aneurism of the internal carotid artery.³ Dr. Stephen Smith,⁴ in confessing an error of his own and recording one or two others, comments on the difficulties of diagnosis, which, I think, he somewhat exaggerates, by showing that no *one* symptom of aneurism, as given in surgical works, is pathognomonic. I certainly shall not dispute that contention; it is the collective evidence of all symptoms that must guide the verdict.⁵

Now an abscess firmly bound down upon an artery and inclosed in a tough wall, resembles, in those physical points with which we have to do, a *cyst*—such a cyst, for instance, as may arise in the popliteal space in connection with the knee-joint or with a flexor sheath. All three diseases, aneurism, abscess, and cyst, may present a globular or ovoid pulsatile tumor, forming rapidly after over-exertion, and two of them (cyst and aneurism) may be preceded by the sense of something breaking or giving way; they may all three be devoid of bruit. But the pulsation of the two latter diseases is not distensible, as is that of aneurism; their throb is diminished on flexing the limb and relaxing the fascia; and in this posture they may sometimes be lifted away from the artery, when pulsation ceases entirely or in great part. Often, when the fascia is moderately tense, the beat of the tumor can be detected as being most marked along a line corresponding to the direction and place of the artery.⁶ The tumor does not diminish and increase on compression and release of the vessel above. In some cases such a cyst may be emptied by

¹ Klinische Chirurgie, S. 95.

² Gazette des Hôpitaux, 1879.

³ Zeitschrift der Chirurgie, Bd. xiv. Heft. 1 and 2, S. 2.

⁴ American Journal of Medical Sciences, April 1873.

⁵ The point on which Dr. Smith lays most stress as most diagnostic, is the past history of the patient, more especially the sense of something having given way. I cannot say that I have found patients' accounts of former sensations at all reliable; they are often taught them by their questioners. Mr. Holmes (St. George's Hospital Reports, 1874, p. 177), in commenting upon this paper, brings very much into prominence, as the one reliable symptom, the bruit. I have seen so many aneurisms without bruit, while so many non-aneurismal tumors with bruit are recorded, that this symptom appears to me one of the least valuable; certainly its absence indicates very little. But especially valuable, when anatomical situation permits the test, is diminution in the size of the tumor on pressing the artery above, and its rapid increase when the vessel is released.

⁶ An aneurism springing from the front of the artery and growing towards the bone may present this linear pulsation, but it is increased on extension of the limb.

pressing the fluid into the joint or other cavity with which it, perhaps, may still be connected; but this will occur as quickly when the artery is at liberty as when it is compressed, and the refilling will be slow and equable, not the sudden rebound of a replenished aneurismal sac.

CASE VI.—In the year 1879, a patient was sent to me, by a very excellent provincial surgeon, with a supposed popliteal aneurism which had made its appearance after an unusually long walk. By the light of the symptoms above referred to, I made it out to be a synovial cyst communicating with the knee-joint. Both the sensation of something having given way, and the power of emptying the tumor, followed by slow refilling, existed.

Cysts of the neck, situated over the carotid, are some of them easy, others difficult, of diagnosis. The ordinary hydrocele of the neck, in its mode of growth and pulsation, in the ease with which it may (unless very large) be lifted from the vessel, and often in its translucency, is quite unlike aneurism. Cysts connected with the thyroid more closely simulate aneurisms in their physical properties; but I have never seen such a tumor which did not rise with the trachea when the patient swallowed; and never a carotid aneurism which did so.

Hæmatocele of the neck, when it pulsates, is often excessively difficult of diagnosis, especially if it has originated in the rupture of some vein just before it enters the jugular; for such a cyst cannot be lifted up from underlying parts. Nevertheless, the linear character, or at least the non-uniformity of pulsation over the whole mass; its position, generally outside of the usual place of aneurism; the fact that it remains of the same size if the artery be compressed below, or, when that is impossible, above; and the fact that pressing the tumor back towards the spine increases the pulsation,¹ mark pretty clearly the probable nature of the case.

CASE VII.—In March, 1876, a man, aged 43, came under my care into Charing Cross Hospital, with an inflamed, pulsatile tumor of the neck, situated on a level with and a little outside of the bifurcation of the carotid. The man was among other things a prize-fighter, and had often received blows upon the front of the neck. The tumor had made its first appearance, small and painless, twenty-one months previously. He asserted that six months before he could see it beat more plainly than on his admission.

The pulsation was not uniform, being more marked on the inner, and less on the outer part of the tumor; it was increased on pressing the lump backward towards the spine, and then was almost or quite uniform. Compression of the carotid below seemed to one of my colleagues to render the tumor somewhat flaccid; this was to me very doubtful. The part was inflamed and very painful, the skin over it red.

In consultation, we agreed to pass in a very fine exploratory trocar; the result was the escape of dark, grumous blood, mixed with what seemed to be decomposed pus; but the instrument was immediately plugged by shreds, and only a drop or two was obtained. Different opinions were formed: one surgeon thought that the tumor was a consolidated aneurism, now suppurating; one declined to decide; while I believed it to be a suppurating hæmatocele. The man was ill, with very high temperature; and seeing the danger of blood-poisoning, I determined to take upon myself all risks. Having prepared everything for tying the carotid above and below, if necessary, and for compression on Chassaignac's tubercle, I opened the sac just enough to admit my forefinger. Detritus of old clots, pus, and purple-brown blood, all mixed together, followed the first incision, but my finger corked the wound, and at that time very little escaped. I broke up all soft and flocculent tissue, but could find no opening as into a vessel. Mr. Hird, at my request, now commanded the artery. I removed my finger and let the ill-odorous, grumous fluid escape, and syringed out the cavity till it was quite clean; a drop or two of bright-colored blood came away. Very slowly and gently the pressure on the carotid

¹ A pretty well-marked, but transient, increase in size and tenseness follows such distal compression, if the tumor be aneurism.

was removed, but to my relief no hemorrhage occurred. During the next week every precaution to meet such an event was adopted, but the emergency never arose. The man suffered a slight pyæmic attack, which, indeed, had existed before the operation; but he recovered without any local disaster.

Cyst or Abscess coexisting with Aneurism.—A cyst may, as a great rarity, lie over and conceal an aneurism; or, more commonly, an abscess may arise around such a tumor, so that the pus bathes the outer surface of the sac. Great embarrassment of diagnosis must, especially if no bruit exist, be thus produced. Yet a certain flaccidity follows compression on the artery above, and deep palpation will generally detect pulsation. Dr. Haens, as quoted by Dr. Stephen Smith, opened an abscess of this sort; eight days afterwards the aneurism burst, and hemorrhage ensued. Mistake could hardly be imputed to the surgeon; the diagnosis of abscess was correct, but the whole disease was not made out.¹ When an abscess opens into an aneurism (the same thing may happen to a cyst), or into a previously healthy artery, the wall of the abscess becomes the aneurismal sac; the symptoms of abscess and of aneurism become combined. Bruit will almost certainly be present, and flaccidity must surely, in all cases, be produced by commanding the circulation above; it is hardly possible that both these symptoms should be absent.

Let me again especially point out that the presence of fluctuation, inflammation, and redness of the skin, with an appearance of pointing, in no wise negative the presence of aneurism. Where the slightest doubt exists it is better to temporize; a few days often bring a difference that clears up the obscurity.

Solid tumors overlying an artery often closely resemble aneurism. Dr. Erskine Mason records an error made by himself and many consultants, in considering a sarcoma in the popliteal space to be an aneurism,² while Dr. Dunning made the opposite error of cutting into an aneurism (popliteal) which was supposed to be a sarcoma.³ Similar errors have been made by English and Continental surgeons; it will be perceived, therefore, that sometimes the simulation of one disease by the other must be very close.⁴

Most sarcomatous, malignant, and cystic tumors are less definite in outline than aneurism, less even on the surface, and less globular. The bruit, if any exist, is not the peculiar whirr or blowing of an aneurism, nor is the alternation of loudness and softness with systole and diastole as well marked as in that affection; it is rather a confused, indefinite, and nearly equable murmur or rushing sound, the intensity of which varies at different parts of the tumor.⁵ Many of these tumors, those, namely, that are very vascular, or that contain blood-cysts, become smaller and softer when the artery above is compressed, but less rapidly than an aneurism, and, on releasing the vessel, the refilling is not with such a sudden bound, nor does the pulsation recommence at once with the same—its usual—degree of force, but, beginning with less, attains in a given number of beats its accustomed intensity. The pulsation varies in strength in different

¹ An additional reason for caution in dealing with fluid tumors over an artery.

² Dr. Mason especially says, "On applying the stethoscope there is heard a loud and distinct bruit," but he does not say if the test by emptying and refilling of the sac was attempted. (*American Journal of the Medical Sciences*, Jan. 1877.)

³ *New York Medical Record*, August 5, 1876.

⁴ Jessop (*Lancet*, Jan. 4, 1873) tied the femoral artery for a supposed aneurism, occupying the lower two-thirds of the thigh. The pulsation was weak, and ceased on compressing the artery above, but the tumor did not diminish in size. Thirteen weeks after, gangrene supervened; in the sixteenth week she died. The tumor was a fibroma.

⁵ Mr. Holmes remarks (*St. George's Hospital Reports*, 1874), that the amount of sound is not commensurate with the size of the tumor; but I am not aware that in aneurism the loudness of sound depends at all on the size of the tumor; very large aneurisms often emit a very gentle bruit, or none at all.

parts of the tumor, and is less expansile than that of an aneurism: it is not so clearly a centrifugal distension, but more like an upheaval of the whole mass by a wave from beneath. In these cases an exploratory puncture helps hardly at all, since sarcomas, cystic growths, and aneurisms, may all furnish blood. This blood, or any shreds in it or on the nozzle of the exploring canula, should be investigated, since the elements of a neoplasm might be found. Or, if doubts were strong, a very small tissue-extractor might be employed. If the disease be in the abdomen or iliac fossa, the urinary sediments should be subjected to the microscope, since in Mr. Moore's case¹ the urine contained cancer elements. Difficulties in the diagnosis of abdominal aneurism will be referred to hereafter, but a case may be here mentioned:—

CASE VIII.—A woman, aged 42, was, in the early part of 1869, under the care of Dr. Head, and dying of Bright's disease. She was also supposed to have an abdominal aneurism, which occupied a space two inches below the xiphoid cartilage; to the right, reached the level of the umbilicus; and to the left, where was the chief bulk of the tumor, ran below that spot. I often, for the sake of study, compared this case with one of abdominal aneurism in a neighboring bed. The expansile heave of both tumors was identical; neither had any bruit. The woman succumbed to her kidney disease in five weeks. It was then found that the supposed aneurism was an abnormal lobe of the liver, which lay on and almost encircled the aorta, and, coming forward, pulsated against the abdominal wall.

MALIGNANT TUMORS, ESPECIALLY OF BONE.—Even more difficulty is encountered when the diagnosis rests between an aneurism and certain tumors which possess an inherent pulsation of their own. The coincidence that such growths should be situated close to large arteries, is less unusual than might at first glance be supposed, since those trunks lie generally on the flexor side of limbs, coursing through spaces filled with lax areolar tissue and with lymphatic glands—with, in fact, that sort of structure which is commonly the seat of cystic and malignant growths. The diagnosis between aneurisms and certain forms of cavernous or erectile tumors, myeloid growths, soft, spindle-celled sarcomas, or encephaloid cancers, especially if highly vascular or studded with blood-cysts having very intimate relationships with the vessels, is exceedingly difficult, and depends upon certain differences in the mode of pulsation and of emptying and refilling, in consistence, and in the character and amount of sound, which can only be detected by very practised persons, and, in some cases, if the disease be deep-seated, not even by the most skilful. Errors have occurred in the practice of very eminent men, even when others of equal position have been called in consultation. I need hardly quote the well-known paper by Mr. Moore,² on a case of supposed aneurism of the common iliac, which turned out to be encephaloid; or the case of Sir James Paget, who cut down on the external iliac with the intention of tying that vessel if the doubtful tumor should turn out to be an aneurism, the operation being abandoned, since the growth seemed to be a cancer. The man died of hemorrhage from the disease, which, on post-mortem examination, was found to have been after all an aneurism.

The difficulty of diagnosis is increased by deep position of the disease, and by hard consistence of the parts from which it springs or by which it is surrounded; for this reason, as also from similitude, the pulsatile tumor of bone, especially if deep, as in the iliac fossa, is one of the diseases liable to be mistaken for aneurism. But, besides the character of the pulsation and bruit being, as above specified, rather different from that of aneurism, certain changes in the form of the affected bone may, on careful examination, usually be

¹ Med.-Chir. Trans., vol. xxxv. p. 459.

² Ibid., p. 468.

detected. Its outer layer expands into a case for the base of, or may send out spiculae and ridges into, the mass; or an outlying spur of the tumor may eat away a portion of the bone, and be pulseless; or, again, the tumor may occupy both faces of a flat bone, such as the ilium, and may thus betray its real nature.¹

II. ANEURISMS WHICH DO NOT PULSATE present to the surgeon very difficult problems. Probably aneurisms proper (that is, not cirroid aneurisms, nor wounded arteries) only cease to beat under three conditions: (1) Consolidation, involving the part of the artery implicated; (2) Rupture and diffusion; (3) Compression, by the sac, of the artery above.² That errors may arise is shown by the case quoted by Mr. Erichsen, of an amputation at the thigh for supposed tumor, the disease turning out to be a popliteal aneurism spontaneously cured.³ Nor do I know of any positive signs by which to distinguish between a solidified aneurism and other hard tumors. The history of the case and the age of the patient must be taken into account, but the great aid to diagnosis will be the more or less globular form of the tumor, its isolation from adjacent parts, and the fact that it does not increase (if really solid), but rather decreases. Certainly, in such a case, no mutilating operation should be performed, particularly if the lump were seated near one of those arteries known to be eminently prone to aneurism.

Ruptured Aneurisms.—An aneurism which has burst widely and largely, filling the limb and distending the fascia with considerable blood-effusion, is hardly to be mistaken for any other condition. But if the sac has given way to a very slight extent, after the manner to be presently described, the greatest embarrassment of diagnosis may arise, for the effused blood may not stain the skin by showing through it, or by producing ecchymosis; indeed, the surface is often unusually white, while the superficial veins, the main one being compressed, mark themselves out in a distinct meshwork as they do in cases of deep, rapidly growing tumors. Moreover, the blood, being slowly effused, partially coagulates, covering the aneurism and percolating the tissues, so that the swelling has neither definition nor pulsation; and as the clotting is generally irregularly disposed here and there among the tissues, an uneven consistence and a nodular surface are produced. Position, too, may cause part of the effused blood to gravitate to some distance, so that the tumor appears to spring from some point a long way from the artery. The pulse beyond is usually weakened, as is common in aneurism, but this, in the cases we are considering, is probably due to pressure of the tumor, which commonly grows either equably or, not unfrequently, remittently.

Judging from the cases of this condition which I have seen and very carefully studied, the correct diagnosis is only to be made out from the history, when that is sufficiently clear; a reference to the medical man who may have seen and treated the patient before such obscurity arose, will always be desirable. Fortunately, this embarrassing condition of the disease is rare; an error, unless it lead to free incision, is not of vital importance, since if the

¹ A case of pulsatile tumor on the head came under the care of Bardeleben in 1876. It must have presented unusual features, since that surgeon diagnosed it as an aneurism of the middle meningeal artery. The matter attracted considerable attention in Germany, as so rare an affection was likely to do. Several operations were performed, including ligation of the internal carotid. The child was not benefited, but lived for some years. After death the tumor was examined, among others by Virchow; it was a large spindle-celled sarcoma growing from the diploe. (*Zeitschrift der Chirurgie*, 1877.)

² This last must be rare. I give it on the authority of Pirogoff. If such a condition does exist, it must lead rapidly to spontaneous cure.

³ If one may judge from the illustration (*Science and Art of Surgery*, vol. ii. p. 291), the error in that case must have been a difficult one to make.

aneurism arise on the trunk, quietude and rest will in all probability be the treatment adopted; if on a limb, amputation will be resorted to; and this is the course which, if such an aneurism were diagnosed, would be the proper resource, as more likely to save life than any other course. A certain number of errors have been made, and doubtless will be made again. Thus, in 1866, my late colleague, Mr. Hancock, amputated the thigh of a man for supposed sarcoma of the popliteal space. The disease proved to be a ruptured aneurism in the above condition. Some of the effused blood was solid, some semi-solid, a little quite liquid. No history of a previous tumor, pulsating or otherwise, could be obtained.¹ A little further on are the details of a case in which my diagnosis (not my practice, as the case was not my own) was in fault (see Case IX.).

PROGRESS OF ANEURISM.

The tendency of aneurism is towards rupture; but this tendency is modified and controlled by so many circumstances that such an event may be rapid, greatly retarded, or altogether obviated; indeed, the tumor may be spontaneously cured, or may, if unfavorably situated, destroy life by methods other than hemorrhage.

Fusiform aneurisms, if at a distance from the heart, and neither cerebral nor pulmonary, do not often burst spontaneously, or, at least, such an event is long postponed. Sacculated and racemose aneurisms, if uncured, generally terminate by rupture.² Those which grow most quickly are most imminently exposed to such a result. The systemic causes of rapid increase are a powerful heart and a strong circulation; hence, youth and vigor, or a hypertrophied ventricle, as also restlessness and recalcitrance to the salutary ordinance of quietude, are potent auxiliaries of rapid growth. I have also observed that when the patients are decidedly rheumatic, and still more if they have recently suffered from acute rheumatism, the aneurism grows quickly, even though there be no cardiac hypertrophy.

Local anatomical conditions which conduce to rapid increase, are proximity to the heart; the situation of the tumor in a cavity, or surroundings of loose, unresisting tissue; a large size of the sac's mouth relatively to that of its body; an absence of active clot, whether owing to the shape of the tumor or to the quality of the blood; and inflammation, suppurative or otherwise, in the immediate neighborhood, whether produced by the pressure of the tumor or of independent causality. From all these considerations, it is evident that aneurisms are of very variable duration; nor must the various points above noticed be overlooked, when methods of treatment involving danger are under consideration.

RUPTURE OF AN ANEURISM does not mean the slow yielding of dilated arterial coats, whereby the tumor, formerly inclosed in altered arterial tunics, comes to be no longer entirely thus surrounded, but is at some smaller or larger spot simply encapsuled by condensed adjacent structures, perhaps strengthened and padded by active clot (p. 840). Most of the large aneurisms which I have dissected, have thus been "consecutive." The word "rupture,"

¹ The limb was injected and split longitudinally. One-half is in the museum of the College of Surgeons, the other in Charing Cross Hospital.

² That is, unless pressure on some part destroy the function of a vital organ. The aneurism of which Mr. Liston, the celebrated surgeon, died, did burst; nevertheless, the hemorrhage was small, and pressure on the trachea was, together with rupture of the aneurism, the cause of death.

as used here, denotes that at some point the blood of the tumor is no longer circumscribed within a sac wall, however constituted; but that through a rent, greater or less in size, it has escaped, either outside of the body, into previously unaltered tissues, or into a cavity, passage, or duct.

The first form of rupture can only be by an open wound, sometimes traumatic, sometimes pathological, as when a phagedænic sore, or an abscess already discharging externally, opens also into an aneurism. In such an event, the more or less sudden appearance of a stream of bright arterial blood denotes with sufficient clearness what has occurred. Unless this be checked by nature or by art, faintness, deliquium, and death, soon follow. If checked, reaction of the system may yet bring on another hemorrhage, perhaps to be effectually commanded, perhaps proving fatal.

If the sac burst into a cavity or tube, the symptoms vary according to the situation and function of the part; their description must be relegated to a future occasion. But here we may notice certain differences as to the mode in which an aneurism bursts into serous or mucous-lined cavities. In the former case, the event is usually rapid; the rent is slit-like or stellate, with ragged edges; sometimes, if the sac have for some time pouched into the cavity, a considerable amount of thickening subtends or surrounds the opening. But rupture into a mucous cavity is a slower process, the round or nipple-like intrusion becoming first either ulcerated or gangrenous, when a little sinus-like track, or a small crack, permits the remittent escape of a few drops of blood at variable intervals. Afterwards, perhaps on some exertion, voluntary, emotional, or reflex, the slough or the floor of the ulcer gives way, and a sudden gush of blood into the cavity destroys life, either simply by loss of blood, or by interference with the functions of the inundated part. Occasionally, however, an aneurism thus ruptured may, nevertheless, continue to increase, and, the hemorrhage being small, may destroy life by pressure. If an aneurism burst into a joint, the synovial sac becomes exceedingly swollen, tense, and very painful; in some cases it pulsates. The diagnosis is then facilitated; otherwise it must chiefly be founded on the history, and on the many points of difference between this state and an acute synovitis.

Aneurisms, too, may open into large veins, or even into one of the chambers of the heart. This subject will be discussed under the head of arterio-venous aneurism.

An external aneurism may become ruptured without any outer wound diffusing its blood among the tissues of the limb. The rupture may either take place by a large rent and a sudden subfascial hemorrhage, or very much more slowly. In the former case, the symptoms are strongly marked and alarming: the patient generally feels something give way, or snap; then has a sickening sense of faintness; has to sit or lie down; becomes pale, and covered with clammy perspiration; and complains either immediately, or very soon, of violent pain in the limb, which rapidly swells. The tumor, whose existence was probably known, loses its definition, perhaps its outline altogether; that is to say, although the general tumefaction chiefly gathers about the site of the aneurism, no distinct and separable tumor can be felt there. Pulsation altogether ceases, not merely at its old place, but throughout the limb, except at its top; thus, for instance, the lower end of the axillary, or the common femoral, may be felt to beat, but below no arterial pulse can be found. The whole part feels numb and helpless to the patient, pain being to him the only sign of its life. Very soon it becomes hard, cold and brawny; then blotches of ecchymosis form on some parts, while in others mesh-works of veins appear. Subsequently, the whole becomes of a lurid red or dusky purple, and then, if the patient still live, gangrene announces its advent by the appearance of bullæ filled with serum stained of a deep purple or dusky crimson hue. These

symptoms may succeed each other by degrees, or may all be crowded into an hour or two, according to the extent of the rupture.

Rupture into an Abscess.—Inflammation and suppuration of the parts surrounding an aneurism are by no means uncommon; they may be traumatic, may originate in over-exertion, or may arise spontaneously—simply from the pressure of the tumor. Inflammation from the last-mentioned cause rarely occurs in an aneurism situated amid lax areolar tissue, but if the tumor press upon more irritable and more resistant parts, such as muscles, nerves, synovial membranes, and more especially the skin, even a moderate-sized aneurism may set up surrounding inflammation;¹ therefore an abscess superficial to the sac is not very uncommon, and is the complication which probably has most frequently led to infelicitous incision. The inflammation is not always confined to adjacent parts; it probably may sometimes originate in the sac, but more often attacks it simultaneously with, or soon after, its commencement in other structures, causing it to soften, together with the clot, which more or less slowly breaks down into a spongy, barely consistent pulp. Hence if such an abscess be opened or break, the discharge may at first be pure pus; but after a few hours or a few days, staining of a brownish purple, and the discharge of dark flocculi, will follow, and then a gush of bright arterial blood. Sometimes, if the aneurism have contained but little clot, the flow of blood occurs without warning.

Sometimes the abscess breaks into the aneurism, or the aneurism into the abscess, before the occurrence of any opening through the skin;² the pyogenic membrane may then not be firm enough to resist the pressure, which will still further inflame the already affected skin, and external rupture, if the case be left to itself, will, under such circumstances, be only a question of a few hours.

Suppuration of the Sac is a name commonly used to indicate that the aneurism itself is primarily and principally affected; probably it is not quite accurate, or rather does not express the whole truth, as surrounding parts are in all probability involved. Every aneurism in which blood has undergone passive clotting, is in some danger of suppuration (see p. 858), but there is no doubt that Broca and his immediate followers somewhat exaggerated its frequency.³ When this accident occurs, the tumor, which already has hardened and has ceased to pulsate (from the formation of clot), becomes very tense, as also very painful and tender, with a sensation as of a tendency of something within the limb to burst. It is curious that, although the patient may have had no sense of pulsation while it was present, he will now feel a painful throbbing in the non-pulsatile tumor. These local symptoms are accompanied by considerable pyrexia, rigors, foul tongue, etc. After a few days the tumor, which has been abnormally hard, becomes diffused and softer. The termination depends upon whether the artery is and will remain sealed: if this be the case, an abscess containing broken down clots as well as pus results; if the vessel be or become patent, the mixture of abscess and ruptured aneurism occurs, as just described.

A small rupture of a non-suppurating aneurism gives rise to no violent or very urgent symptoms; faintness, etc., very slight and transient, succeeds, and accompanies some pain, and a more or less localized swelling of the limb; but the tumor itself loses its definite outline, and ceases to pulsate; and generally, and more particularly if the patient walk about and take exercise, some of

¹ The absorption of bone has been already alluded to; the pain so often accompanying this process points to its inflammatory nature.

² The symptoms of such a condition are given at p. 846.

³ Many forms of treatment, now frequently used, cure by producing passive clot, and that without the frequent occurrence of suppuration.

the more severe symptoms of the larger form of rupture will after a time supervene. If now rest be enforced, and if the aneurism be situated among firm tissues, coagulation of the effused blood may occur, and thus a fresh consecutive sac may be formed; after a time pulsation returns, the tumor again becomes defined, and the patient regains his former state, the aneurism, however, being larger.¹ More rarely still, after clotting of the extravasated blood, that which is contained in the sac may likewise become consolidated.

Another mode of rupture, which takes place, unsuspected, much more commonly I believe than is usually supposed, is a slow leakage from between the laminae of the clot which generally forms, in part, the sac of every aneurism which has attained a certain size, and which is not fusiform. No constitutional signs mark the moment of such an occurrence, even if it can be said to have a definite commencement: the oozing is intermittent; during, and for a certain time after its occurrence, the pulsation either ceases or is greatly diminished. The after events depend in part upon the submission of the patient to rest and quietude, but chiefly upon the sort of tissue in which the aneurism lies. If this be firm, the blood becomes circumscribed; if it be lax, as at the root of the neck, in the axilla, or in the prevertebral region, large non-circumscribed extravasations may form, and that without signs of hemorrhage, since the slow and gradual loss tells upon the system in much the same way only as any wasting disease. I can hardly illustrate this condition better than by the following case:—

CASE IX.—In December, 1877, a man was in Charing Cross Hospital with a tumor in the left supra-clavicular region. This tumor bore no resemblance to aneurism: it seemed to spring from under the upper margin of the scapula and the trapezius, and to extend forward towards the clavicle; it was soft, but not quite soft enough to be called doughy, of very unequal consistence, and nodulated on the surface; it had neither pulsation nor bruit. The transversalis colli and the supra-scapular arteries could be felt beating in their course over the surface of the tumor which pressed them forward. The pulse on the left side was a little weaker than on the right, but the difference was not more than could be accounted for by pressure of any swelling or tumor on the subclavian. At the time of my first examination, I heard only a very indefinite history of aneurism; but I learned that the man's arm had been œdematous, and that he was a sad drunkard. He had a pale, sodden, lymphatic appearance. I negatived the diagnosis of aneurism, believing the tumor to be of a glandular nature, and that it had probably first originated in irritation of lymphatic glands, produced by their giving passage to a quantity of œdematous fluid.

In March, 1878, Mr. Hulke, under whose care the man had been in the Middlesex Hospital, read a paper on the case, detailing how he had cured the patient of subclavian aneurism by rest and low diet. I confess that the diagnosis seemed to me now still clearer, for Mr. Hulke's skill in diagnosis permitted no doubt of what had been the man's disease when he had been under that surgeon's care; and if Mr. Hulke had cured in that man a left subclavian aneurism, how could a growing tumor, above and behind the clavicle, be such an aneurism? The late Mr. Maunier and Mr. Marrant Baker suggested the idea of ruptured aneurism, but Mr. Hulke himself negatived the suggestion.

Some time, I suppose nearly a year, afterwards, chance threw this man, then an inmate of a workhouse infirmary, in the way of Mr. Baker. At that time, the condition of the parts affected was in an exaggerated degree that which had been described by me while he was in the Charing Cross Hospital. "An enormous, semi-solid mass occupied the supra-clavicular, infra-clavicular, and axillary regions,² and in this no pulsation could be detected."

After another interval, the post-mortem record follows: "An immense diffused aneurism was found occupying the whole of the left side of the neck, from trachea to ver-

¹ The increase having been so rapid or sudden should lead to a strong suspicion of what has occurred.

² When I saw him, the supra-clavicular was the only region involved.

tebræ, passing down behind the clavicle, filling the axilla, and through the superior aperture of the thorax into the left pleural cavity, occupying its upper third, and compressing the lung. It evidently had sprung originally from the left subclavian artery; for a portion of the latter for about two inches of its length, beginning just beyond the thyroid axis, was completely obliterated as a tube, and actually formed part of the anterior wall of the aneurism. Beyond this, for about an inch and a half, the vessel was normal, and on the axillary artery was a second aneurism of a fusiform shape, the size of a walnut, and completely plugged by laminated coagula.

"The main aneurism possessed anteriorly a well-formed sac, which was altogether deficient posteriorly, being replaced by the natural tissues. It was filled partly by firm, decolorized, and partly by loose, dark clots, in large quantity."¹

This case requires little comment: it will of itself show the enormous difficulties under certain circumstances—indeed I might say the impossibility—of arriving at a correct diagnosis. The effusion of blood was so slow that the tumor went on increasing for about seventeen months before it reached the size described by Mr. Baker. At an earlier stage, when I saw it, its mode of increase caused it to exactly simulate a deep-seated, nodulated, glandular tumor, even to the characteristic pressing forward of the smaller vessels, while it had lost all the characteristics of aneurism. It had neither pulsation, bruit, nor pressure-pains, either on bone, nerve, or trachea—in fact, no trace of aneurism save the history. Enigmas so insoluble as that furnished by the above case are fortunately rare.

SPONTANEOUS CURE OF ANEURISM.

Spontaneous cure of aneurism may be produced by causes conveniently divisible into three categories:—

- (1) Deposit of clot (active or passive) in the sac.
- (2) Rupture of the sac.
- (3) Inflammation,² suppuration, or gangrene of the sac.

SPONTANEOUS CURE BY COAGULATION.—Of these methods, the first, the most usual, and the most to be desired, is divisible into two, viz., consolidation by *laminated or active*, and that by *loose or passive* clot; both may, or may not, be accompanied by obliteration of a certain length of the artery above and below.

The immediate causes of clotting within the sac may be either general or local.

The former consist of circumstances which so lower and depress the systemic circulating power, that the blood in the aneurism flows with a languid motion which greatly favors its coagulation. Such causes may be found in certain depressing and debilitating maladies, or may be artificially induced, as, for instance, by a greatly restricted diet, certain medicines, venesection, etc.; and, indeed, under either of these conditions, consolidation of blood within the sac has several times taken place. Another and very opposite condition may conduce to cure, viz., some severe inflammatory disease affecting a totally different part of the body. Thus a case of subclavian aneurism be-

¹ For these details, see an excellent paper "On Aneurisms which do not pulsate," by Mr. Morrant Baker. (St. Bartholomew's Hospital Reports, vol. xv. p. 75.) With characteristic courtesy, seeing that my diagnosis was erroneous, that gentleman has suppressed my name. I have no objection, however, in the almost impossible circumstances of the case, to acknowledge that, and to show how and why, I was wrong.

² The older writers considered all obliteration of the aneurism and the implicated artery as an effect of inflammation. This erroneous view led to many misinterpretations of occasional phenomena.

came solid during a severe attack of enteritis, and one of femoral aneurism during acute rheumatism.¹

The local conditions are manifold, and must, to a certain extent, be matters of speculation, since when an old aneurism is found after death filled with firm clot, it will very generally be impossible to prove the circumstances which led to its solidification; yet, I think, we may take the following account to be correct.

It was pointed out a few pages above that most sacculated aneurisms contained, besides fluid blood, a certain amount of firm, laminated clot. This deposit rarely lines the sac throughout, but is situated in those parts of the cavity in which, from its shape, the blood stream is slight and slow, in which indeed, there may be a sort of backwater or counter-eddy, very tranquil, almost moveless. Fusiform aneurisms are, by their very form, precluded from possessing such quiet nooks or recesses, and hence they are less often and less richly provided with that lining of clot. Moreover, even sacculated aneurisms springing from a great length and from a wide periphery of the vessel—that is to say, having a large mouth in proportion to the size of the sac's body—are of less favorable form for the accretion of active clot than are those which stand out from a small section of the artery, and which have a small aperture of communication with the lumen of the vessel. A rough, uneven inner surface, or one divided into ridges and pouches, acts very favorably in promoting this process, and therefore, when once a certain amount of such a coagulum has been formed, it has great tendency to increase by deposition upon it of fresh layers of fibrine from the passing blood.

From this it will be plain that some aneurisms are so formed that one or other of the systemic conditions above mentioned, or some occurrence about the sac or the vessel, suffices to add the slight movement necessary to produce entire obliteration of the cavity; such are said to have a great tendency to spontaneous cure. Others are so constituted as to be very recalcitrant.

The circumstances which may occur to produce such a local retardation of the blood stream as shall lead to a freer deposit of clot are: fortunate form of tumor and situation of the usual clot deposit, favoring further extension of coagulum; pressure of the aneurism on the artery above or below; and displacement of a flake of the clot, and its impaction in such a position as to narrow the mouth of the tumor or of the efferent artery, if the aneurism be fusiform.

Concerning the first of these, little more need be said than has been said already. Laminated fibrine in a sac has always a tendency to growth, which may be frustrated by energy of circulation, constant movement, or a thousand other circumstances; if now such a patient have some temporary malady enforcing quietude, if the circulation be for some days depressed, if during a heavy sleep he lie in some position which may retard the blood-stream in the vessel implicated, he may by any of these, as by other fortunate circumstances, superinduce upon the old coagulum a new deposit, in a situation so opportune that the current in the sac is greatly lessened, and that the solidification of its whole contents becomes a mere question of more or less time. This process may take place in any sacculated aneurism, even though it spring from the largest vessel of the body.² The development of a new aneurism high up on any

¹ Archives Gén. de Médecine, 1824, and Pathological Trans., vol. vii. p. 201. The influence of acute inflammations in producing a rapidly fibrinating tendency of the blood is well known; I have, however, said only "may conduce," because further examples are required to establish a relationship of cause and effect between the existence of one disease and the cure of the other.

² Mr. Erichsen says "This process can only take place in aneurisms affecting arteries of the second and third magnitude, and never in those of the aorta." It is, however, not very uncommon to find in the post-mortem room cured and unsuspected aortic aneurisms. Dr. Cockle

given artery has occasionally, by slackening the blood stream in the vessel beyond, cured an older aneurism lower down.

That an aneurism may cure itself by *compressing its own artery*, either above or below the mouth, is a speculation first advanced by Everard Home,¹ in 1793; he was followed by Hodgson and Crisp.² Broca and Holmes throw some doubt on the possibility, or, at least, the probability, of such an occurrence. It is quite true, as Broca points out, that the cases cited by Hodgson are by no means conclusive; but it is impossible to deny that aneurismal pressure may obliterate an artery, while we have before us such a case as is detailed by Sir Astley Cooper.³ The aneurism, which in this case was aortic, curled backward, and compressed the left carotid with such power as to cause its obliteration. If an aneurism, though it spring from a larger vessel, have power by its pressure to obstruct a healthy artery, there seems no reason to suppose that it would not also cause consolidation in an aneurismal sac; for in the first instance, total, or very nearly total, occlusion would be required; in the second, a mere mitigation of the blood-stream will often, as frequent experience has shown, procure solidification of the blood. I watched for several weeks, with great care, an aorto-innominate aneurism, which, advancing outward, bent down behind the clavicle and compressed the subclavian about its third part. Under this pressure, the outer part of the large tumor was gradually becoming solidified in the most interesting manner. But the man insisted on taking a long journey and going from care before the completion of the process, which, under fostering and favoring circumstances, might have led to entire cure.

If a cure have been effected by any of these means, obliteration of the artery up and down to the next large branch will generally occur in such vessels as the popliteal or femoral, but it is always secondary to the consolidation in the sac. In certain other vessels, as in the thoracic or abdominal aorta, the innominate, and usually the subclavian, unless the aneurism have been very large, the vessel preserves its permeability; the consolidated aneurism simply rests upon it, and the surface of the active clot, which is washed by the circulating stream, becomes coated with a smooth, shining tunic, indistinguishable from the normal inner coat of a healthy vessel.

A third local condition which occasionally leads to the cure of aneurism, is by *detachment of a flake or shred from the usual incrusting clot*. Such a shred may be only partially loosened from a spot near the mouth of the tumor, so that it flaps over the orifice, and, swaying in the current, acts as a valve, only mitigating, not entirely obstructing, the stream; or it may, whether quite detached or no, be washed into the vessel beyond, block it up entirely, and act as a total check to the circulation. The former method may, if the passage of blood be very much obstructed, give rise to the same symptoms as the latter, but if the circulation be merely retarded, no disturbance further than some coldness and numbness of the parts beyond, together with hardening and diminished pulse of the aneurism, is perceptible.⁴

The sudden occlusion of an aneurismal vessel by a detached piece of clot, is followed, unless the vessel be of unimportant dimensions, by a sudden,

(Lancet, vol. i. 1869, pp. 422-489) has described several such. Broca and Hodgson have each depicted one such cure. The mistake is a very important one, as likely to influence erroneously the practice of those who confide in Mr. Erichsen's generally excellent work.

¹ Transactions of the Society for the Improvement of Medical and Chirurgical Knowledge, vol. i. p. 140.

² On the Structure, Diseases, and Injuries of the Bloodvessels, p. 178.

³ Med-Chir. Trans., vol. i. p. 12.

⁴ Some of these symptoms depend upon the size and situation of the vessel. Thus, a blood-clot impacted in the aorta would cause much disturbance in certain vessels of the brain, with paralysis, or even death.

sharp pain in the limb, and by a sense of giddiness, faintness, and sometimes sickness. The pain in the part beyond increases, and then passes into severe tingling and heat, culminating in numbness and entire uselessness, closely simulating paralysis; indeed, the muscular helplessness may sometimes be combined with paralysis. The tumor ceases to pulsate, and the artery beyond to beat, the limb becoming cold and bloodless in some cases, while in others it is blue and gorged with venous blood. Gangrene is often imminent, and, doubtless, would more often supervene, if such conditions were not, as a very general rule, judiciously treated by covering and sufficient warmth. Many of these symptoms are common both to impaction and to rupture; the point of difference is chiefly to be found in the absence of swelling, and in the more or less gradual subsidence of the painful and even alarming phenomena.

RUPTURE OF AN ANEURISM occasionally, though rarely, leads to a spontaneous cure. I saw, six years ago, a case which I am sure was one of ruptured popliteal aneurism, the consolidated blood compressing the artery and causing its obliteration, though not suddenly or rapidly; indeed, I was for three weeks ready at any moment to amputate the gentleman's thigh, and he was prepared to submit; but he got well after the fashion about to be described.

When an external aneurism bursts, the blood is effused into the tissues, and unless the limb be removed, or the rupture be very small, the patient frequently succumbs with the symptoms described at p. 850. But occasionally, as at that place was noted, the blood becomes encapsuled, partly by its own coagulum, partly by inflammatory thickening of adjacent parts. If the effusion have from the first been limited to a small spot by fascia, if the thickening be considerable, and if a proper amount of support be given by bandage or otherwise, the vessel becomes to a certain degree compressed, and, especially in a case so old that pretty large collateral branches have already been formed, may be obliterated. The patient having passed through a very imminent danger, very rapidly becomes a sound man again. This at least is the process which I believed I could follow in the case above alluded to. But having no anatomical fact to prove it, I would rather quote a very similar one—save that the patient suffered relapse—viz., Case XVIII. in Hodgson's work:¹—

CASE X.—A gentleman, about thirty years of age, after a day's hunting, felt a pain in his thigh, which he considered as rheumatic. A month afterwards he perceived a small, fluctuating tumor in the course of the femoral artery, about four inches below Poupart's ligament. The tumor increased, and the leg and thigh became œdematous. He was bled copiously, and restricted to a low diet. Compresses were applied above the tumor, in the course of the femoral artery, as high as Poupart's ligament, and the limb was rolled equably and tightly from the foot to the groin. The application of the roller increased the pain, and he suffered much from fever. This plan was continued for some months, when, on a sudden, the whole limb became extremely cold and benumbed, the tumor and upper part of the thigh put on a livid appearance, and serious apprehensions were entertained for the safety of the limb, which was hourly expected to become gangrenous. On the morning after this alarm, the pulsation in the tumor had ceased, but the livid color and the defect of circulation continued. The pain had abated, the fever was less, and the warmth of the limb began to return, and the size of tumor to diminish. From this time the patient continued to recover, but it was long before the limb regained its natural sensation, or the œdema subsided. At the end of six months he suffered no inconvenience from the remains of the disease, except that the upper part of the thigh was four inches larger in circumference than the opposite limb in the same situation. In this state he remained twelve years, when the swelling began to enlarge, and was attacked with a dull pain after violent exercise.

¹ The author gives it as a cure by pressure of an aneurism on its own vessel, a manifest error.

From this time the tumor gradually increased. When I saw him (says Hodgson), twenty years after the commencement of the disease, it had grown to an immense size, but did not possess any of the characters of aneurism. It had a firm, fleshy feel, and was void of pulsation, while no fluctuation could be detected in it. It continued to increase for two years, when the apex sloughed, and a quantity of brown sordes was discharged, mixed with clot, which had very much the appearance of lamellated coagulum in a putrid condition; no hemorrhage took place. A large cavity was thus exposed, the surface of which assumed a sloughy aspect, and the patient died in consequence of the fever and irritation with which it was accompanied. Upon dissection, the sides of the tumor, consisting of a firm, fleshy substance, were found to be in a sloughy condition; but no large vessel communicated with the cavity. The femoral artery, before it penetrated the tendon of the triceps, was obliterated for the space of three inches.¹ The body of the sac was reflected upwards upon the obliterated portion of the artery, which must have been compressed between the sac and the femur.

This narrative, highly characteristic in its first symptoms, and in the persistency of limb enlargement, differs from the type of such events in one particular only. If, after rupture, the patient does not succumb, but remains well for six months, and, *à fortiori*, for a year or more, he may, as a rule, be considered fairly safe from the consecutive gangrene which attacked this man after so many years. In all cases of recovery after such symptoms, the patient is, for about the period above specified, that is, from six months to a year, in constant danger, not as much from hemorrhage as from inflammatory destruction of the infiltrated tissues. As long, therefore, as measurement of the one limb against the other shows a large difference, so long does this danger exist. The vessel upon which the aneurism is seated usually becomes sealed; if when the tissues slough or suppurate, hemorrhage occur, it will be from other collateral branches, some of which open into the cavity, and, often thin and dilated, yield to the sphacelation.

CURE BY INFLAMMATION OF THE SAC, ETC.—If the mode of spontaneous cure, just described, be most dangerous, indeed merely a narrow escape from death, so also, must we avow, are those now about to be specified, namely, inflammatory changes of the sac and its contents. It is to be observed that inflammation may be superinduced upon any of the processes, natural or artificial, which produce passive clotting of the blood; indeed, such a form of clot is apt to act as a foreign body and set up inflammation. And it is a little remarkable that inflammation of the sac and its surroundings tends to the formation of passive clot. It is difficult to account for this circumstance; we must be content with recording the fact.

Inflammation of the sac and neighboring parts is stated by Crisp and Hodgson to be capable of curing aneurism simply by producing clotting of the blood, and I believe that this may sometimes occur. The inflammation may arise from traumatism, as from a blow, strain, or over-exertion, etc., or may be produced simply by the pressure of the tumor. As long as the sac lies amid loose and insensitive areolar tissue, such irritation cannot take place, but when it comes to press on more sensitive parts, more especially on the skin, inflammatory conditions are by no means uncommon.

If resolution result, no effect will probably have been produced on the aneurism, or if any hardening and diminution of pulsation have occurred, such signs of amelioration may be merely temporary, the loose clot with which the sac has been in part filled being so soft that it easily breaks down and

¹ This is ambiguous. I presume Hodgson does not, by triceps, mean the adductor magnus; probably the canal, Hunter's, between the vastus internus and the long adductor, is intended; if so, the superficial femoral would have been obliterated up to its junction with the deep (profunda) branch.

is carried away in the blood current. The disease reverts to its former condition, except that the sac wall is probably softer, more distensile, and more fragile than before. But in some rare and most fortunate cases, the tumor, which at the first advent of inflammation became more tense and had a more violent pulsation, ceases either slowly or suddenly to beat, becomes harder, and, when the inflammation has subsided, may begin slowly to diminish.

Suppuration, another result of the inflammation, may at first involve simply surrounding tissue, or the aneurism alone; more commonly it attacks simultaneously both parts. Wherever the commencement may be, it is a highly dangerous condition, which, however, though it usually results in loss of limb or life, may lead to cure.

An inflammatory abscess adjacent to an aneurism runs the usual course: enlarges, points, is opened, or bursts; pure unstained pus comes away, if the inflammation have been severe and extensive enough to close with clot not only the aneurism, but also the implicated vessel; and, if time enough have elapsed to permit the formation and adhesion of coagulum, no further accident may arise. Unfortunately, the course of events is more often thus: the artery may never have been filled with clotted blood, or, if so, only with friable clots which soon soften and break down, so that a few hours or days after the discharge of pus, a gush of bright blood, which may be either sudden or preceded for some hours by sanguinolent pus, places the patient in such imminent danger that amputation is urgently demanded. Or the abscess may open into the aneurism before pointing on the skin; or, again, suppuration may occur within the sac and in its neighborhood simultaneously. The symptoms of the former condition, prior to bursting or opening, are obscure, but when either of those events occurs, the admixture with the pus of loose, tawny-purple coagula, and generally of fibrine in lamellæ, sufficiently indicates the nature of the case. Suppuration within the sac, which must always be looked for when there is reason to believe that as a result of inflammation it has become filled with passive clot, is marked by extreme tension and hardness, some increase of size, and a sense of throbbing in the non-pulsating tumor, the pain being considerable and imparting a peculiar sense of bursting. The occurrence of hemorrhage when an opening, artificial or otherwise, is made, depends upon the presence and density of clot in the vessel, rather than in the aneurism; it must always be remembered that, although no bleeding may occur at the time of opening, the vessel may, by breaking down of the soft clot, become permeable, so that a sudden gush may destroy the patient, or that slighter and recurrent hemorrhages may cause the loss of either limb or life.

A few cases have occurred¹ in which, after discharge of pus and clots, and after one or more attacks of hemorrhage, the abscess has contracted, the bleedings have ceased, and the patient has been cured of the aneurism; the process whereby this takes place is obscure, and the event is too rare to affect prognosis.

Gangrene of the sac is also extremely dangerous, but not as often from immediate hemorrhage as from exhaustion and its results, because the gangrenous condition is usually accompanied by inflammation sufficient to close the vessel. It is not common in deep aneurisms surrounded by cellular tissue; but attacks rather those that grow so rapidly as to press upon more sensitive parts without affording them time to accommodate themselves to the disturbance, and it is especially liable to occur when the skin becomes rapidly stretched. This structure, when gangrene threatens, becomes shiny on the surface, of a dusky

¹ See Broca, Des anévrysmes, etc., p. 167; Hodgson, p. 103; and Crisp, p. 107.

red hue, and almost insensitive; then a patch puts on a bluish, bruised look, and becomes afterwards of a brownish black. If the vessel have remained patent, a little sanguinolent oozing from cracks in this dark spot forebodes an imminent hemorrhage which will not be long delayed. If the implicated artery have been sealed, lump after lump of detritus, consisting of sloughed tissue, partially decomposed active and passive clots, together with a quantity of foul pus, comes away; the patient escapes hemorrhage, but is in great peril of exhaustion and blood poisoning.

These modes of spontaneous cure have been dwelt upon at considerable length, because they are most important: many of them as indicating methods to be pursued, others as illustrating dangers to be avoided.

In order to afford a compendious view of these processes I will place them in tabular order:—

MODE OF CURE.	PRODUCED BY
1. Deposit of clot, active or passive.	<div> <div>Lessening the quantity of blood in the body.</div> <div>Lowering the heart's action.</div> <div>Form of tumor.</div> <div>Diminution of blood stream through the artery.</div> <div>Pressure of aneurism on artery.</div> <div>Displacement and impaction of a clot.</div> </div>
2. Rupture of sac.	<div> <div>Traumatic.</div> <div>Over-rapid growth.</div> </div>
3. Inflammation, suppuration, and gangrene.	<div> <div>Traumatic.</div> <div>Presence of passive clot.</div> <div>Rapid growth and pressure on irritable tissues.</div> </div>

TREATMENT OF ANEURISM IN GENERAL.

All methods of treating aneurism are founded upon the processes of spontaneous cure, every one of which has been imitated by art. It need, however, hardly be pointed out that that natural process which is the safest, is the one most worthy to be copied; hence, several modes of treatment which aimed at cure by such dangerous routes as rupture or suppuration of the sac, have fallen into complete, or almost complete, disuse;¹ nor would it answer any good purpose to discuss here obsolete methods which are now mere matters of history.

At the present day, the treatment may best be divided into the medical or systemic, and the surgical or local.

I. MEDICAL TREATMENT OF ANEURISM.

The medical treatment of aneurism is founded on the method of Valsalva, which aims at reducing the quantity of blood, and lowering the action of the heart,² by “keeping the patient in bed about forty days, during which time one or more venesections should be practised, enemata be used, wine be forbidden, and only such an amount of food and drink be given as is enough to support life; and indeed not merely in two portions in the whole day, but the

¹ Mr. Syme revived some years ago the method of Antyllus, founded on rupture.

² Valsalva left behind no writings on this subject; but his friend, Hippolytus Franciscus Albertinus, in his work entitled *Animadversiones super quibusdam difficilis respirationis vitiis, a læsâ cordis et præcordiorum structurâ pendentibus* (1748), has given a complete account of the plan which both together had devised.

daily portion should be administered on [divided between] three or four separate occasions, so that the small quantity given at each may never fill the bloodvessels." The same, or much the same, regimen, with the exception of bloodletting, is even now practised, and has of late been more particularly recommended by Mr. Jolliffe Tufnell.¹ The regimen as at present adopted may be described as entire rest, with either a low diet or a dry diet. The rest is to be in bed, and the patient must be enjoined to refrain from frequent movement of the limbs—if the aneurism be thoracic the arms are to be employed as little as possible—contrivances for holding a book or other articles being provided. The change from total² to semi-recumbency is all that should be permitted, and even in this the patient should be helped. He should not get out of bed for any purpose whatever.

The low diet may be arranged somewhat on this pattern—Bread, 10 ounces; butter, 1 oz.; rice or tapioca pudding, 6 ounces; milk, 1 pint; this amount, divided into three or four meals, should suffice, as a general rule; but some patients, especially among the less educated classes, to whom physical privation is unbearable, become recalcitrant under such restrictions, and it may be advisable to allow once or twice a week a little fish or some boiled meat. The dry diet may be formulated thus—for breakfast and supper, bread, 4 ounces; butter, $\frac{1}{2}$ oz.; milk, 2 ounces. For dinner, meat, 3 ounces; bread, 3 ounces, water or milk, 3 ounces. If the quantity of fluid can be still further reduced, some advantage may be gained, and thirst can be obviated by occasionally sucking a small piece of ice, or by gargling the throat with iced, acidulated water. If after either of these plans has been carried out for six weeks, the aneurism have become consolidated, or if, on the contrary, no benefit have resulted, the return to a fuller and more natural regimen must be very cautiously made; the increase must be slow and measured, and its effect must be carefully watched.

I cannot but think that the reaction against the too copious and frequent bleedings of our forefathers is somewhat excessive. Indeed, at the present day, if a patient should be bled to the amount of a pint, his friends would, probably, ascribe all the subsequent evils, inseparable from his disease—perhaps even his ultimate death—to the venesection. Nevertheless I have no hesitation in saying, that, in certain cases, a suitable and perhaps a reiterated bleeding would, at the commencement of treatment, save much time, and enhance the efficacy of the diet system. This would more especially be the case, when, from pressure upon large veins, much congestion existed—the air-tubes being narrowed and the lungs hardly able to aerate the quantity of blood sent to them. In all such cases, to diminish the mass of blood in the system gives rapid relief; but this must be done cautiously, since syncope must not be risked. The mere influence of bleeding on the action of the heart is, however, not the only point to be considered; its effect on the blood itself is well ascertained, and even more important—namely rapid coagulation. This has been well shown by Thackrah, Gulliver, and others, and is one of nature's most potent means of arresting hemorrhage. In such cases the facility with which the blood coagulates is in very close proportion to the amount which has been effused.

Medicines, therefore, which act by simply reducing the force and rapidity of the heart's action, cannot tend as directly to the cure of aneurism as a bleeding which has an equal cardiac influence; but they may in other ways be less injurious, and their effects may certainly be recovered from with less diffi-

¹ The Successful Treatment of Internal Aneurism, etc. London, 1864; 2d edit., 1875.

² Some patients with aortic aneurism cannot lie down; they must be supported day and night in a half-lying posture.

culty. Thus, such drugs as *belladonna*, or its alkaloid,¹ and *hydrocyanic acid*, may be used, and with a certain advantage. The former drug has the effect, in thoracic aneurisms, not merely of lessening the rapidity of the heart's action, but also of alleviating pain; and, more especially if there be dyspnoea, of diminishing the laborious efforts of obstructed respiration. I have found less benefit from *digitalis*. Great caution in the use of this drug is necessary, since its action appears cumulative; and after long administration, with apparently little effect, it occasionally retards the cardiac pulsation suddenly, and sometimes to an alarming extent. *Tincture of aconite*, in from two to five minim doses, every three or four hours, will generally rapidly reduce the pulse to sixty in the minute, and to a more feeble beat. The action must be carefully regulated. A case of Dr. Pancoast's (subclavian aneurism) got well while the patient was suffering from a poisonous dose of aconite given by mistake. *Veratrum*, if used at all, may be most safely employed as veratria ointment over the chest, if the skin be unbroken.² The action should, however, be very carefully watched. In one case in which I thus used it, relief, and I think a certain amount of retardation in the growth of the tumor, ensued.

Bromide of potassium is of decided advantage when pain or irritation arises from direct pressure on nerves. I have seen the irritating and distressing cough which is caused by disturbance of the recurrent laryngeal nerve, in certain cases of thoracic aneurism, much mitigated, and in one or two instances almost subdued, by twenty-grain doses of this drug; I have seen, also, severe pain from pressure on the popliteal nerve almost disappear.

Iodide of potassium has by some writers been greatly extolled. It was first employed in aneurism by Dr. Chuckerbutty, of Calcutta, who noted the consolidation of an aneurism while the patient was for some other disease taking large doses of that drug. Since then it has been by some surgeons largely employed. My own experience, like that—as he tells me—of Sir William Gull, and that of Mr. Holmes,³ is not favorable, although under certain conditions, to be named immediately, the drug may alleviate. There is, since direct experiment on the human subject is inadmissible, very great difficulty in either proving or disproving the value of a drug in this sort of malady. We cannot isolate it; we cannot give the drug and do nothing else. Thus, in turning to published records we find always that patients who come under treatment are placed at entire rest, debarred from stimulants, and given low diet; when, if the iodide be administered, the advantage gained is put down, in whole, or in great part, to the use of the drug. Nor have I been able to find a single case in which the medicine, given without these more potent elements of success, has proved curative of the aneurism. On the other hand, there are a great many⁴ records of patients who, after improving under the whole system of rest, diet, and drug, have got tired of restraint and resumed their ordinary mode of life, and then, though still taking large doses of the iodide of potassium, have quickly relapsed, and generally rapidly died.

The theory of the syphilitic nature of atheroma and aneurism is one reason

¹ The most reliable, and, indeed, the only stable compound of atropia is the salicylate. The formula is this:—

Take of Atropia,	.	.	.	5	grs.
Salicylic acid,	.	.	.	7½	grs.
Hot water,	.	.	.	10	fluidounces.

Rub the atropia down first into a very fine powder, then little by little mix the salicylic acid with it; add slowly the hot water. The whole must dissolve, and the solution must measure or be filled up to 10 fluidounces. The dose is 10 minims—that is, $\frac{1}{16}$ grain of atropia.

² The United States Pharmacopeia preparation is 1 in 25; the English, 1 in 60.

³ System of Surgery, second edition, vol. iii. p. 437.

⁴ These are so scattered and so multitudinous that it would be useless to refer to them.

for the belief in the value of iodine; another is the fact that, under certain circumstances, this drug undoubtedly relieves a species of pain which accompanies the growth of certain aneurisms. That wearing and peculiarly distressing pain which is produced by pressure of the tumor on bones and periosteum, is undoubtedly mitigated—may even for a time be entirely subdued—by taking from forty to ninety grains, in the twenty-four hours, of iodide of potassium. Hence a relief of symptoms which by no means implies improvement of condition.

The value of iodine given internally is most marked in periostitis, chronic thickenings, and slow inflammatory enlargements, whether strumous, syphilitic, or rheumatic; in fact, in such conditions as culminate in fibrous or fibrillating deposits. But all cures of aneurism, save those by suppuration and sloughing, are based upon coagulation—upon the fibrillating qualities of the blood—which is antagonized by iodine. I cannot but think that the very rapid relapse and quick progress of the disease which overtakes many aneurismal patients, who at first seemed to derive benefit from the rest and the iodine, is often due to a non-coagulating condition of the blood, produced by large doses of this drug.

II. SURGICAL TREATMENT OF ANEURISM.

Medical treatment is, in certain cases, the only available resource, as in a large proportion of thoracic, and in a few other aneurisms; but for some internal, and for nearly all external aneurisms, treatment applied directly to the implicated vessel—*surgical treatment*, as it is called—can be employed.

The surgical methods employed in cases of aneurism, may be divided into such as aim at cure: (1) By destruction of the sac—they are imitations of the cure by gangrene or suppuration; (2) By applying coagulants directly to the blood, following the method of cure by passive clotting; (3) By mitigating or suppressing the circulation in the vessel and tumor, in order to induce coagulation generally, and preferably by active clot.

As each of these is modelled upon some natural process, so each is liable to the same sources of failure as the spontaneous method of cure which it imitates. The *first* may cause death by exhaustion and blood-poisoning; the *second* exposes to the risk of recurrence, or inflammation with its sequelæ; but the *third*, if successfully completed, affords an entire and permanent cure. The methods employed are as follows: (1) The use of cauterics and the method of Antyllus;¹ (2) Injections of coagulating fluids, the introduction of solid bodies into the sac, the application of heat, galvano-puncture; (3) Manipulation, flexion, various forms of compression, different modes of arterial deligation.

Concerning many of these methods, only sufficient need be said to indicate that they have been used—in order to obviate the possibility of any surgeon, after consulting this work, adopting, under the impression that they are new, plans which have been tried and abandoned as useless or lethal. With this object in view, I shall mention briefly a number of methods, rather as points of science than as examples to be followed, save in exceptional circumstances.

CAUTERIES.—Of the use of cauterics nothing need be said further than that the method has been employed by Chassaignac and Neumann for small aneurisms, one of the palm, the other of the anterior palatine artery. The remedy, successful in both instances, can only be employed when the sac is minute.

¹ The “method of Antyllus” will be referred to in connection with the treatment by ligation.

It imitates the most unfortunate and dangerous form of spontaneous cure, and the practice is certainly not deserving of imitation.

Coagulants applied directly to the blood may be either chemical or mechanical.¹ I shall limit myself to a description of the injection of coagulating liquids, the introduction of certain solids, and galvano-puncture or electrolysis.

INJECTION OF COAGULATING FLUIDS.—Injection of fluids into aneurismal sacs originated with Monteggia,² at the beginning of this century, and shortly after was advised by Wardrop. Various fluids were recommended, but they all yielded after a little to the superior coagulating qualities of the perchloride of iron, with the use of which, and of the fine syringe employed for the purpose, the name of Pravaz is intimately united. Such injections may be valuable in some cases of nœvus and aneurism by anastomosis, but their use in aneurisms proper is only admissible in certain cases. Since each portion of a drop of the solution immediately coagulates into a soft solid the blood with which it comes in contact, means must be taken to retain the little lumps thus produced, in the sac, as otherwise they will entirely or in part escape along the artery below, as emboli; hence the method is only practicable when the vessel can be compressed below and above, so that the chemical may act upon stagnant blood.³

The mode of procedure is as follows: First, the vessel above and below must be entirely commanded, and then the fine needle-canula of a properly-graduated hypodermic-injection syringe is passed with a quick but properly restrained action into the tumor, the appearance of a drop or two of arterial blood marking its entrance; it should next be moved from left to right gently, but sufficiently to ascertain that its end lies in a cavity; then the syringe, filled with the injection-fluid, is to be applied to the socket of the needle, and the requisite quantity very slowly injected, while the point of the instrument is made to change its place in the sac, so as to distribute the liquid into various parts. When the amount fixed upon has been injected, or previously, if sufficient coagulation appear to have taken place, the piston should be withdrawn a little, lest some of the fluid hanging to the end of the needle-canula should irritate the sac, and then the instrument may be removed.

According to Signor Marsacei, the latest writer on this subject, and M. Dieulafoy, a little earlier, the solution should be weak, 1 part of the salt to 15 or 20 of distilled water; and the amount should not exceed five drops to every ounce of blood that the sac may be estimated to contain. After the withdrawal of the needle, the puncture may be protected with collodion, and pressure on the vessel above should be continued for an hour, and on that below for double the time, if it can be borne.

Since coagulant injections can only be employed with some approach to safety from the risk of embolism, when a sufficient length of artery to afford space for pressure lies both above and below the sac, it follows that any aneurism to which this treatment can be applied is well situated for almost any curative means, and the duty of the surgeon is to choose the safest. The danger of embolism may, by great care, and, as I cannot help thinking, by good luck,

¹ Space hardly permits a historic account of the use of a number of coagulants, such as heat, as employed by Sir Everard Home; certain powders; and other means which may be termed eccentric.

² *Institutions de Chirurgie*, 1815.

³ Certain surgeons have thus treated aortic, innominate, and subclavian aneurisms; evidently, from what has just been said, an improper application of the method, and destined to prove injurious.

be avoided; but the danger of suppuration, and even sloughing, of the sac, through the irritation of a loose clot soaked in the coagulant fluid, is ever present, and against such peril, when he has made the injection, the surgeon is all but helpless. There can, I conceive, be very few aneurisms which can safely be treated by coagulating injections, which cannot be less dangerously treated by other methods.

INTRODUCTION OF FOREIGN BODIES.—The introduction of solids into the sac is a method which originated with the late Charles Hewitt Moore, of the Middlesex Hospital, in 1864.¹ He selected for this experiment a case of hopeless thoracic aneurism, introduced into the sac a fine canula, and through that tube passed into the cavity twenty-six yards of fine iron wire. The operation was easy, and almost painless; the hemorrhage slight; but the effect injurious. Inflammation of the sac and of the surrounding parts, certain embolic infarctions of the kidney, great pain, and death on the fifth day, is the summing up of the case.

In 1873, Dr. Levis, of Philadelphia, slightly modified this procedure by using, instead of fine wire, horse-hair.² The aneurism was of the right subclavian artery. The patient died in four days. At the autopsy, the horse-hair was found behind the upper lobe of the lung, the aneurism being ruptured. "On dividing the upper lobe of the right lung, there was found a mass of black, clotted blood, behind it and extending beyond the line of the ribs, especially in the axillary region immediately below the clavicle, nearly two inches. In the upper portion of this soft clot a dense white clot was found attached around the lower aneurismal opening in the subclavian. In the posterior part of the fibrinous clot were found the horse-hairs."

In November, 1873, Mr. Bryant treated in the same way a popliteal aneurism which had resisted pressure, passing into the tumor about twenty feet of horse-hair while the femoral was compressed. "The leg was bandaged with cotton-wool. The anterior tibial could be felt pulsating. Half an hour after the operation, the pulsation had diminished."³ The patient survived four days, the procedure apparently not contributing to death as much as did a heart affection, and the previous very zealous compression for over one hundred hours. The sac was found partially filled with clot mixed up with horse-hair, but, as a month before death it had been noted that there was much clot in the sac, there is plainly difficulty in ascribing to the pressure and the horse-hair their respective shares in the local and general result.

The introduction of needles is a method which dates from the time of Sir Everard Home (1796), who added heat to the mere acupuncture. And the tendency of blood in slow motion to coagulate upon any solid against which a mitigated current may play, has induced many well-known surgeons—Velpeau, Pravaz, Agnew, and others—to try this method, but without much practical result. The most successful case is that of Dr. Macewen.⁴ The aneurism was of the popliteal artery; pressure had been but partially successful; a fine needle was introduced and moved every ten minutes for one hour, during which time, and for fifteen minutes longer, pressure was continued. It is to be observed that the influence of the needle is in this case doubtful; many an aneurism, which had previously resisted, has been cured by the last half hour or so of pressure. Mr. Heath,⁵ after amputating without benefit at the shoulder-joint, in a case of subclavian aneurism, used acupuncture, but

¹ *Medico-Chirurgical Transactions*, vol. xlvii. p. 136. I believe some attempts had, in earlier years, been made to cure aneurism by passing into the sac very fine iron-dust or iron-filings.

² *Philadelphia Medical Times*, March 28, 1874.

³ *Pathological Transaction*, 1877, p. 103.

⁴ *Lancet*, vol. ii., 1876, p. 184.

⁵ *Medico-Chirurgical Transactions*, vol. lxxiii. p. 71.

without good result; he introduced six needles, each pair crossing in the sac, and left them for four days. In his paper he says that Mr. Marshall has on more than one occasion thus produced temporary clotting to a considerable extent. Constantin Paul¹ also employed needles, but kept them in only fifteen minutes on one day, and, after three days interval, one and a half hours; and then, after three weeks, repeated the same two punctures. The benefit was, he affirms, very considerable. Bacelli² advocates the introduction of very fine watch-springs which he believes would provoke coagulation, and then become oxidized and pulverized, and strengthen the clot, but his two cases terminated fatally without any apparent benefit.

Thus a great number of substances have been introduced, some of which are not even here named. No surgeon would choose such treatment if any more efficacious and more direct means were applicable, but in certain cases, when nothing else could be effected, some foreign substance might be employed; I should, however, strongly deprecate the use of iron wire, horse-hair, or such coarse solids, pushed irrecoverably into the body of the aneurism; none of the patients on whom this was done lived long afterward; of course, some clot was found about the coils, but inflammation, suppuration, or even bursting of the sac are all complications to be considered.

GALVANO-PUNCTURE.—Electrolysis or galvano-puncture, as the method may indifferently be called, was introduced into England by Benjamin Phillips, in 1829, as an improvement on Everard Home's idea of coagulating the blood of an aneurism by means of heated needles. But his proposition met with no consideration. Shortly afterwards, in France, M. Alphonse Guérard suggested to M. Pravaz the same idea,³ and that physician, accepting it with enthusiasm, established the method, which has been carried out and perfected more especially by Ciniselli,⁴ and in England by Duncan, Fraser, Poore, and Althaus. It is thus to be carried out. The battery must be of large tension and small intensity, that is, should have a goodly number of small elements; the machine of Stöhrer, or the Leclanché battery as arranged by M. Foveaux,⁵ answers very well, or better still, since in it the amount of immersion can be regulated, the Foveaux-Smee arrangement.

There should be either several—from four to six—very thin needles arranged in a lash on a subdivided conducting cord, or one steel needle, on a single or on both poles; in either case, the needles must be well insulated down to a short distance from the point.

Thus far all are agreed; but beyond this the galvanists differ—one choosing to insert the negative, another the positive, a third both poles; if one only be inserted, the other ought to be applied to the skin, but not over the sac, by means of a wet sponge. From the negative pole, especially if used alone, a froth composed of gas bubbles suspended in a very soft, loose clot is formed. From the positive, a firmer, blackish, but small clot is produced, and there is also formed⁶ a black fluid, which appears to be produced in considerable quantity, in appearance and consistence like thin tar. If a patient is to be subjected to this treatment (and I need hardly say that only internal aneurisms—scarcely any other than intrathoracic—are suited for its adoption), he must be in bed and semi-recumbent, and should not have chloroform or ether,

¹ Gazette des Hôpitaux, No. 54, 1879.

² Bulletin de l'Académie de Médecine, 1878.

³ Lettre de M. Pravaz sur l'Acupuncture de M. Velpeau. Gazette Médicale de Paris, Janvier 8, 1831.

⁴ Sulla elettro-puntura nella cura degli Aneurismi, 1856, and a later, 2d edition.

⁵ Of the well-known firm of Weiss.

⁶ Dr. John Duncan. British Medical Journal, May 20, 1876.

but may, as Dr. Poore¹ has pointed out, be somewhat narcotized by the hypodermic use of morphia. The needles, and I myself prefer to employ both, should be oiled and inserted with a quick but not strong thrust, and when non-contact of the two within the tumor has been verified, the battery is to be connected. The effect on the pulse and vital powers must be watched, and, unless untoward appearances arise, the use of galvanism may be continued for one or even for two hours, provided that no redness appear around the punctures. If both poles have been inserted, the unguarded end of the positive needle will have been almost entirely dissolved away in the time above given, if the action have been sufficiently strong. Removal of the needles must be effected with great gentleness, so as to disturb as little as possible any clot that may have formed upon them, and so as to avoid also any rending which might be produced by the needle-point, which will possibly have been roughened by the solvent action of the galvanic current.

The immediate result is nearly always a certain increase in the hardness of the tumor, and a certain diminution of the pulsation; or at least this feels more distant. The next thing is nearly always that these apparently favorable signs disappear. The clot, if any, which is formed by the galvanic current, is usually as evanescent as the will o' the wisp.

Ciniselli gives the following table:²—

Aneurism of	No. of Cases.	Cures.	Deaths.
Aorta,	37	6	3
Innominate, Carotid, and Subclavian,	13	3	6
External Iliac,	2	1	0
Femoral, Popliteal, and Brachial,	26	16	3
Smaller Vessels,	8	6	0
Total,	86	32	12

a table which I confess to regarding with considerable doubt, not as to the veracity and good faith of the author, but as to the interpretation of the results. I do so because of five patients whose cases are recorded in a later communication,³ three did not even seem to have been benefited, one did so seem for a few days, one went from cure, apparently much benefited, but returned within a month, and died almost immediately from asphyxia. Still more recently,⁴ Dujardin-Beaumetz, in relating to the Société Chirurgicale a case of aortic aneurism which he had treated unsuccessfully by galvanopuncture, quoted a letter received from Ciniselli, whence the following statistics are extracted. Of 29 cases, in 11 the relative improvement had lasted 4 years, 37, 33, 21, 17, 16, 7, 7, 6, 4, 1, months. In 7 others it had lasted 28, 16, 12, 8, 6, 3, 3, months, and still continued. In 11, there had been no improvement.

Experience in other countries has been less favorable, as shown, for instance, by the table given by Dr. Poore:⁵—

Aneurism of	No. of Cases.	Cures.	Deaths.
Thoracic Aorta,	8	0	8
Innominate,	1	0	1
Subclavian, 3d Part,	1	benefit.	0
Ulnar,	1	0	0
Femoral, ⁶	1	1	0

¹ Electricity in Medicine and Surgery, p. 253.

² Sulla elettro-puntura nella cura degli Aneurismi.

³ Sopra alcune Aneurismi della Aorta toracica osservate dopo il 1870.

⁴ Union Médicale, No. 136, 1877.

⁵ Op. cit., p. 253.

⁶ This case having been treated by pressure combined with electro-puncture, renders it doubtful to which the cure is due.

Taking what later (after 1877) records are available, I find 8 cases. Of the several patients.

4 died during treatment,¹

1 was not improved, and died in 13 months,²

2 were benefited, but not cured,³

1 was cured⁴ or greatly benefited.

The aneurisms best adapted to this treatment are, undoubtedly, those about the upper part of the aorta, which are not very large, but which have already perforated, or at least pushed forward, the chest wall. Mere fusiform dilations are probably quite beyond hope of benefit, since the blood must in them sweep past the needles too rapidly to be affected by the galvanic current. A sacculated aneurism with a protruding diverticulum, or, still better, one that is set like a bud on the vessel, and has not too large a mouth, so that the circulation may be somewhat slow, is certainly the most hopeful form for this treatment, because in such a sac the retarded current affords to the galvanism some chance of producing a clot which may afterwards extend, and which is less likely to be washed away.

The dangers of galvano-puncture are bleeding from the needle punctures (hardly to be regarded, unless very large needles have been used); formation of an eschar, or of an abscess, between the skin and sac; inflammation of the sac; embolism;⁵ and sudden depression of the vital powers—but in truth none of these save embolism are very imminent or potent.

We cannot quit this subject without staying to consider the two parts of which the treatment consists, namely, the galvanic current and the foreign body, as likewise the possibility that the presence of the needle has as much, perhaps more, to do with the benefit when it accrues, than has the galvanism. If Messrs. Heath, Marshall, Macewen, and Paul, are correct in their statements, we have evidence of about an equal rate of benefit on the introduction of needles, whether or no they be connected to a battery.⁶ M. Paul, in his paper above quoted, asserts that the benefit in either form of treatment is not due to coagulation, but to an inflammation of the aneurismal wall which thus becomes thickened.

PARENCHYMATOUS INJECTION OF ERGOTINE.—In connection with the treatment by injections, another method may be mentioned, which does not, however, aim to effect a cure by directly producing coagulation, but is rather a topical application of strictly medical measures. The *parenchymatous injection of ergotine* was introduced, in 1869, by Langenbeck, who exhibited two cases so treated at the Berlin Medical Society. He prefaced his remarks with these words:—

“It is well known that in obstetric medicine the *secale cornutum* is a very valuable remedy; it acts by stimulating and calling forth uterine contractions,

¹ Two, Thoracic Aorta. Drummond. *Lancet*, Aug. 9, 1879.

One, “ “ Gardner. *British Medical Journal*, July 19, 1879.

One, Abdominal Aorta. Moudan. *Lyon Médicale*, No. 4, 1879.

² Omboni. The case is described as improved, but it is not easy to see in what the improvement consisted. *Il Raccoglitore Medico*, Febr. 1877. (Thoracic Aorta.)

³ Carter. *Lancet*, Nov. 30, 1878. Boucquoy. *Progrès Médicale*, No. 4, 1879.

⁴ Verradini. *Gazetta Med. Ital. Lomb.* No. 3, 1878. A very rapid, apparent cure (24 minutes); ice and rest afterwards. Relapse in 10 weeks; same treatment again produced seeming benefit, which was of longer duration.

⁵ Dr. Clifford Allbutt found in a case of subclavian aneurism the opposite carotid obstructed. *Brit. Med. Journ.*, May 20, 1876.

⁶ Since this was written, a case has been reported in the *Lancet*, Oct. 22, 1881, of an aneurism, either aortic or aorto-innominate, greatly benefited or perhaps cured by electro-puncture. The surgeon who reports the case, himself observes that, after using the Stührers battery for an hour, he tested the current on his forehead, and found it almost nil, and that therefore the result may have been attributable to the mere presence of the needles.

and thus is also a hæmostatic in post-partum hemorrhage. Hence we may conclude that ergot acts on organic muscular fibres, causing their contraction; it was these considerations that induced me to employ the injection of ergot in a case of aneurism."¹ The material used was the aqueous extract of Bonjean, thus diluted:—

Extract of ergot, $2\frac{1}{2}$ parts.
Rectified spirit,
Glycerine, of each, 7 parts.

He began with 0.03 gramme,² and from the 6th of January to the 17th of February, about two grammes of ergotine were injected, in doses varying from 0.03 to 0.18 gramme, at intervals, as a rule, of three days. An ordinary hypodermic syringe was employed, and the fluid was placed under the skin covering the aneurism. In the first case, one of subclavian aneurism, there was much improvement, considerable diminution both in size and pulsation having occurred.³ Pain, too, almost entirely disappeared, so that, even after the first injection, the patient, who had been very sleepless, and who thought that the medicine was a narcotic, expressed himself as greatly pleased at having passed a quiet night.

Langenbeck's second case was one of aneurism of the radial, as large as a hazel-nut, in which, after a single injection of ergot, the tumor disappeared!

In 1871, Dutoit, of Berne, published a successful case of combined pressure and ergotine injection, in subclavian aneurism, using fifteen injections in thirty-seven days, commencing with half a grain, and ending with three grains.⁴

Another case is recorded by Mr. Carlin.⁵

Thus, although there are to be found scattered in journals and reports a great many instances of ergotine injection, unproductive of any benefit, yet we have clear evidence of its occasional advantage. Certain cases of aneurism, as, for instance, some of the subclavian, especially on the left side, are in such condition and so placed that any more active, direct treatment is inapplicable, or fraught with considerable danger, while medicine and rest produce no salutary effect. Under such circumstances, the surgeon is glad of any procedure which seems to afford some chance, however remote, of benefit. The ergotine injection must thus take its place among the resources of surgery, but if any other means can be employed, too much time must not be wasted upon such treatment.⁶ It is to be remarked that in all the successful cases, more especially in those of Langenbeck, very considerable benefit followed the first injection; hence we may conclude that, unless such advantage be quickly manifested, we may, after two or three repetitions, discontinue the plan as useless.

The formula, as used in England, may be thus given:—

Extract of spurred rye, 1 part.
Rectified spirit,
Glycerine, of each, $1\frac{1}{2}$ parts.

¹ Berliner klinische Wochenschrift, 1869, No. 12.

² 1 gramme is equal to 15.432 grains, so that, the dose of the extract may vary from gr. ss. to gr. iij.

³ I have not been able to find any further report, and know not if the man entirely recovered.

⁴ Archiv für klinische Chirurgie, Bd. xii. S. 1070; this case is again referred to in connection with subclavian aneurism. Dutoit's solution was made thus: Bonjean's watery extract of ergot, 3j; Spirit, glycerine, of each, 3iij. Langenbeck attributes the absence of symptoms of poisoning to the fact that the aqueous solution contains none of the ethereal oil resident in spurred rye. The United States Dispensatory would, in its fluid extract of ergot, have no such ingredients; that of the British Pharmacopœia, being made with ether, would include it; yet both I and others have used our English preparation without such evils as vertigo and sickness.

⁵ Lancet, November 30, 1878.

⁶ A case is related in the Memorabilia, No. 10, 1874, in which after a long time had been employed in the use of ergotine injections for femoral aneurism, they proved useless; a few hours' digital compression cured the disease.

Of this, from ten to fifteen minims may be injected in close proximity to, but not into, the sac.

The third class of methods, viz., those which *mitigate or suppress circulation through the affected vessel*, are by far the most important, since they are the most successful.

MANIPULATION.—The procedure first devised, practised, and named by Sir William Fergusson “manipulation,” rests upon the spontaneous cure by displacement and impaction of clot—a mode which has been shown (p. 855) now and then to occur. Sir William, in two well-known cases¹ of subclavian aneurism, displaced by external pressure with his thumb a certain quantity of the clot which lined the aneurisms. In the one case, pulsation in the vessels below ceased, but only for a few hours; after two attempts the tumor was unaffected, and eight months after it burst. In the other there was no change. A year afterwards direct pressure appeared equally unavailing; the man went to sea, and in yet another year came back with the aneurism solidified. Now, since displacement and impaction of clot, whether fortuitous or induced by art, must needs be a rapid, almost a sudden event, we cannot possibly ascribe the cure, verified two years after, to the manipulation, nor, indeed, to the pressure. The most important point in both these cases is, that the patients suffered certain severe, even dangerous nerve-symptoms—the former merely temporary confusion and giddiness, the latter hemiplegia; the clot had gone the wrong way, and too far, namely, up the carotid. So, also, we find two cases in which the examination for diagnostic purposes of carotid aneurism produced paralysis and death.² On the other hand, three cases recorded by Mr. Teale, Dr. Blackman (femoral aneurism), and Mr. Little, of Donegal (right subclavian aneurism), were successful; but in the first two, pressure having been likewise employed, the share which manipulation may have had in the cure is doubtful. Mr. Little employed no other treatment; no cerebral symptoms supervened. On the third day the vessels beyond pulsated more feebly; on the tenth, not at all. The tumor gradually solidified and ceased to throb. On this one fortunate and in no way ambiguous case we must avoid building too large a superstructure.

The mode of operating is, first, by gentle but continued pressure to empty the sac of its fluid contents, and then, with a brisk movement, to rub the two sides of the aneurism sufficiently forcibly together (Mr. Teale kneaded the femoral aneurism a good deal); and it is well to endeavor to direct any laminae which may be detached towards the distal mouth of the tumor, if it be of the fusiform variety and have two mouths. After this has been done, the result is mere chance. It may be for good, if the loosened clot be of just the size and form to block the mouth of the sac, or if, as I suspect in Little's case, it be only semi-detached, and gradually attract more fibrin. Sometimes, as in Fergusson's case, a promise of benefit may entirely disappear in a few hours. For aneurism about the limbs, any one of the methods about to be described would be preferable, as more reliable and less likely to prove injurious. For aneurisms of the carotid no such method should be tried. There is, too, in both right and left subclavian aneurism, undoubted danger of cerebral embolus by way of the vertebals, and in the former case by the carotid also, since a back flow of the stream probably takes place while manipulation is going on. In certain inguinal aneurisms, other means being almost precluded, the procedure may be attempted.

¹ Med.-Chir. Trans., vol. xl.

² Virchow's Archiv, Bd. xi.; Medical Times and Gazette, 1859, vol. i.

COMPRESSION.—The various methods of employing compression for the cure of aneurism may be conveniently divided into (1) direct compression, that is, upon the tumor itself; (2) indirect compression, that is, upon the artery above or below, these varieties being termed respectively proximal and distal; (3) general compression, that is, pressure exerted upon the whole limb; and (4) compression by means of flexion.

DIRECT COMPRESSION.—Of *direct compression* I shall say but little here. Heister,¹ in 1744, seems to have been the first surgeon who formulated this method, and Guattani,² the first who had some success, more especially in such aneurisms as occur at the bend of the elbow, a frequent sequel, at that time, of accidents in venesection. Guattani's method was more particularly by the use of the bandage and compress; Heister, the mechanical tendency of whose mind is still well known, invented various forms of tourniquet, among others a progenitor of our modern "ring-tourniquet." No doubt some of the persevering efforts which those surgeons have recorded, would have had better chance of success had they been more moderate. The endeavor entirely to empty and keep empty the sac, or totally to eliminate pulsation, led to various forms of accident, such as rupture and sloughing, and in a number of cases to refusal any longer to submit to treatment.

Four cases of cure by this means are recorded by Ciniselli,³ Brunker,⁴ Holmes,⁵ and Buckminster Brown.⁶

CASE XI.—Ciniselli's case was one rather of wounded carotid than of aneurism; a sponge was applied with a flannel bandage around the neck, and therefore could only have exerted very little pressure, at first for from seven to eight hours, and towards the end for fifteen hours daily. In ninety-seven days, pulsation of the tumor ceased.

CASE XII.—Dr. Brunker's patient, a man aged 32, had been undergoing severe bodily labor, and was admitted into the Infirmary, August 20, 1839, with a rather large popliteal aneurism; he was placed at entire rest, with low diet. "Two days after admission, a piece of dry sponge was placed over the aneurism, and retained *in situ* by a roller rather loosely applied." On the 27th of the same month (the bandage does not seem to have been disturbed or renewed in the interval of five days), "I was greatly surprised to find the tumor much diminished in size, and that no pulsation could be discovered in it." The effect of a simple sponge-pad placed loosely on such a tumor could have been nothing, even had the bandage been kept up to its original rather loose condition; the cure—spontaneous, or by rest and diet—happened to coincide, in point of time, with the local application.

CASE XIII.—In 1875 Mr. Holmes treated, at St. George's Hospital, a small subclavian aneurism by binding into the supra-clavicular space a hollow India-rubber ball of due size filled with air. Gradual consolidation took place in about eight weeks.

CASE XIV.—Dr. Buckminster Brown, of Boston, applied direct pressure to a large femoral aneurism; this at first was effected by weights of from 10 to 24 pounds while the patient was in bed, and afterwards by a pad and belt while he went about and attended to his business. The aneurism was cured in six years, and the man lived nearly six years afterwards, dying ultimately from an independent disease.

It is necessary to use great caution in the selection of cases for this plan of treatment; one certainly would not recommend it for aneurisms on parts of a limb where proximal pressure or other means could be employed. In subclavian cases, one would in preference choose those cases in which the sac pro-

¹ Heister, *Dissertatio Med.-Chir. de genum structura eorumque morbis.*

² Guattani, *De externis aneurysmatibus*, etc.

³ *Annali Universali di Medicina*, 1867, p. 351.

⁴ *British and Foreign Med.-Chirurg. Review*, Jan. 1840.

⁵ *Lancet*, Feb. 12, 1876.

⁶ *Boston Medical and Surgical Journal*, 1875.

truded upwards and forwards, and certainly would avoid those in which it extended towards the lung. Direct pressure should very rarely, if ever, be used upon the external protrusion of an intrathoracic aneurism, because it can do no good in promoting cure, but chiefly because that portion of the sac, yielding to each pulsation, serves as a sort of spring, and thus relieves internal parts from suffering the full force of the blood-wave.

When, in suitable cases, direct pressure is used, its action on the skin must be sedulously watched, and any sign of inflammation or any appearance of blood must warn the surgeon at once to discontinue its employment. Suppuration between the skin and the sac, ulceration on the surface, and, above all, a slough over the aneurism, would, in all probability, prove fatal, and would at the least be dangerous and embarrassing complications.

When flexion, indirect pressure, or ligature, having at first appeared successful by cessation of pulsation, seems about to fail by recurrence of the pulse, direct or general pressure is a very valuable resource, and no doubt many relapses have by such means been prevented. A bandage should be firmly, but not tightly, applied from the extremity to some distance above the tumor, between which and the roller, a piece of sponge, a curled horsehair pad, a half-empty India-rubber ball, or some other elastic cushion can be interposed; the toes or fingers, as the case may be, must be examined from time to time, and the absence of commencing gangrene verified.

INDIRECT COMPRESSION.—Indirect compression is a comparatively modern development of surgery, for although in earlier times the direct pressure just described was supplemented by the addition of a hard pad beneath the bandage, over the artery, it is clear that no definite attempt had ever been made to cure an aneurism by pressure—not on the tumor itself, but on the vessel some distance above—until Hunter had shown that a check to circulation at such a place would obliterate the cavity of the sac.¹

Pressure then began to be systematically employed, at first, as ancillary to ligature. In the first quarter of the present century many attempts were made to cure aneurisms by this method alone; but they very generally failed, not as much because the instruments were imperfect, as because such pressure was used that it either could not be tolerated or produced eschars. The first successes belong to Dupuytren, Boyer, and Dubois. The years 1820 or 1824 (we need not follow controversies as to priority), are the time when indirect compression began, through the labors of Dublin surgeons, to take a fixed place in the resources of surgery; the names of Todd, McCoy, Cusack, Crampton, and Bellingham are more especially connected with the various instruments, arrangements, and general regulations, which have caused this method to be other than merely a resource when nothing else could be done.

Indirect pressure is applicable to most external and to some internal aneurisms; it may be applied by means of instruments, or by the fingers of a staff of assistants. These methods are termed respectively, *instrumental* and *digital*, and both may be either *proximal* or *distal*: the latter, however, should only be used when the former is anatomically impossible; it has furnished very few encouraging results.

Both instrumental and digital, proximal pressure may be employed in one of two ways: the first, named “gradual,” is intended to produce a partial occlusion of the vessel, permitting a slender stream of blood to percolate the sac, and thus, by a process somewhat analogous to that which external to the

¹ Broca labors hard to show that the primary idea of indirect compression is French. Boyer and Dubois had the first successes in 1810. Ford's and Blizard's unsuccessful attempts were in 1788 and 1803 respectively. Freer's experiments, on which much excellent work was founded, were published in 1807.

body is called "whipping," to conduce to the deposit, layer by layer, of active or laminated clot. This deposit, if all proceed in the most desirable manner, should, in due course, fill the aneurism, and subsequently also the vessel itself, up to and down to the next considerable branch. Sometimes, however, the clotting in the artery beyond the sac does not occur; and it is probable that certain instances of more or less rapid relapse have been owing to non-obliteration of the afferent and efferent vessels. The gradual method may be continuous or non-continuous. In the earlier days of this mode of treatment, pressure was nearly always kept up unintermittingly, day and night, until it succeeded or had certainly failed. Of late, however, the more merciful plan of non-continuous compression is generally employed,¹ during periods, and at intervals, adapted to the powers and endurance of the patient. It is certainly wise to leave, every night, from four to six hours for undisturbed sleep.

The second method, called "sudden," or "rapid," attempts to do in a certain number of minutes, or perhaps of hours, what by the gradual method is done during days or weeks; in certain parts of the body, notably the abdomen, this is the only available means of making pressure; but it may also be used for external aneurisms. The aid of an anæsthetic (but complete anæsthesia is not needed) is usually invoked, and then by means of the fingers, or some compressor adapted to the part, complete occlusion of the vessel is effected, until, if success is to be obtained, the tumor may be felt to become solid. The pressure is then somewhat relaxed, but is not to be entirely abrogated for a period of at least five hours. For the clot which is produced suddenly, by complete stagnation of the blood, is necessarily of soft, loose consistence; a mere coagulation of fibrine and corpuscles, inclosing in the meshes a quantity of serum. After a time, this semi-solid contracts centripetally, and the fluid becomes squeezed out into the circumference, that is, between the coagulum and the sac. It is to be supposed that, if no blood-current re-enter the aneurism, this serum must become absorbed, and the sac must contract upon the already diminishing coagulum; or if a slight stream do afterwards pass through the tumor, active laminated clot may be formed around the passive one. But it may and does also happen that a relapse will occur; the newly entering blood-current dissolves or washes away the recent coagulum, and the sac is again filled simply with fluid blood.²

But if the surgeon find that, under proximal, rapid pressure, solidification in the aneurism is taking place, he may entertain strong hopes that by cautious management a cure may result. Some dangers are, however, yet to be considered. Broca did, doubtless, very much exaggerate the after dangers of passive clot accumulated within an aneurism, as the vast number of rapid cures by pressure and by the Esmarch bandage show; but there is undoubtedly, in these cases, a certain proclivity to inflammation and suppuration of the sac. Sometimes the effect of proximal pressure, either gradual or sudden, is the direct contrary to that which is intended, viz., a marked and rapid increase in the size of the sac. It is difficult to account for this phenomenon, but we know that it is not very infrequent, and that it is a strong warning to the surgeon to discontinue the treatment lest rupture take place. Indeed, this untoward event has occasionally occurred.

Indirect, instrumental pressure on the proximal side of the tumor has been most frequently used with success in popliteal and in femoral aneurisms, but has also proved efficacious when applied to the brachial, subclavian, and com-

¹ Sometimes called dis-continuous.

² This question of relapse after apparent solidification, presents a hitherto unsolved difficulty. I am not aware that any facts go to show that clotted blood can be redissolved in flowing blood; and yet we know that clots formed after the above manner in aneurisms do disappear without producing embolism of the vessels beyond.

mon or external iliac arteries, as also to the abdominal aorta. It may be carried out according to either the gradual or the rapid method. The former of these consists in the application of some instrument, generally some ingenious modification of the tourniquet, according to the vessel to be compressed and the shape of the parts, with sufficient force to greatly diminish, but not altogether to suppress, the blood-current through the tumor. Generally it is advisable to inclose the limb below the point of pressure, or, at least, below the tumor, in some soft form of bandage—Domett or fine flannel—applied either in the form of a roller, or cut into proper lengths as a many-tailed bandage. Since the treatment is not intended to effect any sudden, or indeed any very rapid changes, and since no point of the skin can bear continuous pressure for more than a short period, two places for its application are chosen, two instruments or a double-armed instrument being used, so that the localities of compression can be alternated. Many surgeons prefer, instead of the second tourniquet, certain forms of weight. Three details of management are, above all others, those that most conduce to success: (1) Regulation of the pressure, so that a continuous, slight stream may go on through the sac; (2) Avoidance (in some parts) of pressure on the main vein; (3) Great attention to preserve and keep in good condition the skin at the points of pressure.

Few conditions in surgery vary so much and so unaccountably, in different cases, as the tolerance of patients for the irksomeness of confinement to bed and the retention of one attitude. Nor must it be taken for granted that all the ordinances of the surgeon are to the letter carried out, or that all displacements of the instrument are entirely accidental. In every case, even when the patient has the best intentions, great vigilance must be exercised; for often uncontrollable restlessness, severe pain, or the exhaustion of sleeplessness, breaks down his powers of endurance. Hence, it is well to have two reliable nurses, intelligent enough to manage the instruments, who shall never leave the patient alone; better still, to have two or three steady and careful assistants, one of whom can be always on the spot, to direct the treatment.¹ The administration of anodynes and narcotics is often necessary. Chloral hydrate, bromide of potassium, and morphia, are all valuable. Aconite is especially lauded by some surgeons as lowering the action of the heart, while it also soothes nervous irritation. Belladonna, or rather atropine, is very valuable when it is tolerated. In spite of all these adjuvants, the patient's courage not unfrequently gives way, the chief causes of failure being pain, culminating in agony, irritability, and exhaustion.

Digital pressure is frequently preferable to instrumental pressure for brachial, femoral, popliteal, and especially for high carotid aneurisms; it is to many patients less wearing, and is less likely to produce inflammation at the part compressed. The treatment is, however, attended by many difficulties, especially if it is to be carried out away from a large town, in which a medical school may provide a sufficient staff of trained, reliable, and patient assistants. Three at least of such should always be with the patient, and these should be relieved by a fresh relay every three, or, at most, four hours. Two should be occupied simultaneously about the patient, one to keep his hand on the aneurism, and, by observing constantly the amount and mode of its pulsation, to direct another who compresses the artery. Lest he who is exercising compression should become fatigued too rapidly, a weight, either a shot bag or a moulded piece of lead, enveloped in wash leather, should be provided, which, being suspended by a cord over the bed, and laid upon his fingers, supplements and economizes muscular force. Even with this aid, the hand becomes, in the course of a few minutes, too tired and numb to efficiently compress the

¹ More full descriptions are given in connection with the treatment of popliteal aneurism.

vessel; the assistants then change places, and the second undertakes the duty of watching the aneurism, while the first becomes the compressor, and so on, alternately, until it be necessary to call in the aid of the third assistant, or to make an entire change. Of course, the place of pressure must be occasionally shifted, if the anatomy of the part render such a change possible. Under all circumstances, the condition and behavior of the skin must be very carefully watched during the whole time, and signs of inflammatory complications among deeper parts must be looked for, any such condition negating a continuance of the treatment.

Neither instrumental nor digital pressure need be kept up uninterruptedly until the cure is complete or failure accepted. That method, called the continuous, is for most patients unbearable, or at least very painful, and, if it last long, exhausting. The interrupted mode—sometimes termed, not very elegantly, discontinuous pressure—is far more supportable, and, to judge from records, quite as successful, though, of course, less rapidly so than the most fortunate examples of continuous pressure. As the name denotes, the treatment is carried on only during a certain number of hours of the day, the night generally being set aside for repose. While the instrument or fingers are off duty, the limb, if the position of the tumor be favorable, may be kept in flexion, or simply bandaged with a pad over the sac, to make slight direct pressure. Sometimes the treatment may be altogether suspended for several days, or longer, and then resumed. If the aneurism do not grow, and if the patient's condition of health be such as to forbid more active measures, this treatment may be carried on at intervals for a very long time, and success be even thus ultimately attained. In one case of femoral aneurism (already quoted) which was treated by direct compression,¹ the surgeon began with the use of weights, and afterwards substituted pressure with a pad and belt, and let the patient move about. After six years the tumor became solid, and the patient lived several years longer.

Pressure, either instrumental or digital, may be used on the *distal side* of the tumor, as a mere adjuvant to proximal compression; or sometimes, as in aneurism low down on the carotid, as the only feasible method of treatment. Certain abdominal aneurisms may be dealt with in a similar manner, but with less chance of success, distal compression having less scientific applicability here than in the case of the undivided large trunk of the neck. It should never be employed on any other artery, save as a mere aid, if proximal pressure be possible.

Rapid Pressure Method.—However employed, indirect pressure by the gradual method occupies a considerable time,² and hence is, for many persons, inadmissible, while others will not submit to long and irksome treatment, the result of which is, to a considerable degree, uncertain. Again, some forms of aneurism, chiefly of the abdominal aorta, cannot be dealt with after this method. The *sudden* or *rapid* method of using compression was introduced by Dr. Murray, of Newcastle-on-Tyne.³ The patient, a spare man, aged 26, was subjected to pressure, with a horse-shoe tourniquet, on the aorta, just below the margin of the left ribs, at first for two hours, without avail, and three days afterwards for five hours. During both periods anæsthesia was maintained. The pressure was such as to stop pulsation in the tumor, in the aorta below, and in the femorals at the groin. At the end of the second attempt the aneurism was found to beat much more feebly, and in a day or two it became completely consolidated. This rapid mode of compression has

¹ Brown, Boston Medical and Surgical Journal, 1875.

² Nineteen months is, I believe, the longest period of treatment recorded, but seven, five, and four months are not infrequent.

³ Med.-Chir. Trans., vol. xlvii. p. 187, 1864.

been adopted, also, in other cases of abdominal aneurism, and occasionally with success.¹ Brilliant as the cure, when it occurs, may be, the method is not without danger, not only to the aneurism, but also to the peritoneum and viscera at the point of pressure.

The same means are used also for aneurisms of the limbs; indeed, since the success of the method in abdominal cases, and the occasional rapid cures by the Esmarch bandage and by flexion, some considerable modification in the views of surgeons has taken place; even the Irish school no longer so strongly insists upon the necessity of permitting the continuance of that slight stream through the tumor—that gentle thrill of the sac—which seemed to them formerly an essential. Many now prefer to entirely occlude the artery, permitting no wave to pass. If to do this a great degree of pressure is required—such a degree as even morphia will not render bearable—an anæsthetic is given, and its action maintained for several consecutive hours, as many as eighteen, with just a short interval, perhaps, for giving food; or the patient may be fed by the rectum. A certain number of persons are able to bear such pressure as will completely eliminate pulsation without this aid, even though repeated at no long intervals for eight or ten hours at a time; and after even as long a period as six months, the method may succeed or may fail.² I cannot say, however, that such persevering—I had almost said obstinate—adherence to one method is deserving of imitation.

GENERAL COMPRESSION.—Another method is to apply pressure to the whole limb, which may be best done by the use of the Esmarch bandage; it is most suitable for aneurisms situated some distance below the proximal joint of a limb, but may also be used as a species of distal pressure below an axillary or an inguinal aneurism.

Esmarch's bandage was first employed for the cure of a popliteal aneurism by Dr. Reid, at the Royal Naval Hospital, at Plymouth, in September, 1875, after failure of proximal pressure by Carte's apparatus. The flat elastic bandage was rolled on the limb from the toes upward to the upper third of the thigh, being wound only loosely over the tumor. The cord was then placed *in situ* to compress the vessel, and the roller removed. In 50 minutes the pain became unbearable; the Carte's compressor was then lightly and intermittently applied for some hours, but merely as a precautionary measure; for by the suppression of the circulation the aneurism had been cured, and pulsation never returned. Many cases of aneurism, more especially popliteal, have since been treated in a similar manner, sometimes successfully, sometimes the reverse.³ Nine months after his cure, Dr. Reid's patient died of heart disease and bronchitis; the popliteal artery was found occluded for 2½ inches by "fibrous tissue," and chiefly above the sac; the vein was pervious. Collateral vessels ran as usual, communicating with the artery above and below. The sac was well defined, being thicker where it joined the artery than elsewhere. The centre, and also the portion of the cavity adjacent to the vessel, were occupied by an amorphous, non-laminated, coffee-colored substance of the consistence of cheese, which showed no signs of organization, or of vascular connection with the surrounding parts. The portion of the circumference of the cavity of the aneurism opposite its mouth, was occupied by several layers of laminated fibrine. Some of these were partially separated from the others, and approximated towards the centre; the interspaces thus caused were filled with amorphous substance, which, however, was of a looser character than that already described.⁴

¹ See section on treatment of abdominal aneurisms.

² See case in Dublin Journal of Medical Science, 1877.

³ Statistics will be given on a subsequent page.

⁴ Lancet, vol. ii. 1875, and vol. i. 1877.

These appearances, showing that the cure had been by the method of passive clot, were very characteristic. The laminated portion of the clot had evidently been formed before the bandage had been applied, coagulation having been aided or produced by the previous pressure. Shreds of this material had become detached in the application of the flat bandage. The unorganized material was that which had been produced by the Esmarch method; it filled the part of the sac next the artery (the last portion which becomes occupied by active clot), and encased the detached part of the laminated strata. The mode, then, in which Reid's method may cure an aneurism is, if the tumor be included in the flat bandage, a combination of pressure and manipulation; but where the sac is excluded, it acts by simply stagnating the blood, and thus permitting simple coagulation. Mr. Gould¹ considers that coagulation commences in the vessel, and that to its occlusion the cure is due—a view which cannot, I think, be maintained, and which certainly has not been proved.

It is desirable to so employ the apparatus as to have the aneurism, and the vessel a short distance above and below, well filled with blood. Thus, suppose the aneurism be popliteal, the flat bandage should be applied from the toes to near the lower margin of the sac; then the patient should be made to stand, and another similar band tightly rolled on the limb from just above the tumor to the top of the thigh; then, when the recumbent posture is resumed, the round cord is to be adjusted, and the flat bands removed. Other surgeons simply bandage the limb, the patient lying down, with the flat elastic, taking care to keep the turns that encircle the sac looser than the rest. For the first few minutes this appliance is very tolerable, but after that time the part begins to be very uneasy, and then increasingly painful. Few patients can endure the pressure for more than half an hour; but this inconvenience may be partially obviated by beginning with a narcotic, or entirely eliminated by ending with an anæsthetic. The limb should be kept pulseless, unless circumstances forbid, for an hour; but, during that time, the extremities, fingers or toes, must be watched, lest gangrene should suddenly supervene; the state of the circulation generally should also be sedulously attended to. Before the cord is removed, a tourniquet should be placed on the artery above, and screwed down sufficiently to command the stream and prevent a sudden flow into the sac, which might carry away the soft recent clot; or the same end may be obtained by digital pressure. After removing the cord, the surgeon may, while keeping his hand on the tumor, let an assistant slowly relax the pressure, while he watches for pulsation; even if no, or, *a fortiori*, if a slight wave appear, compression should be continued for at least two hours. If, at the end of that time, some thrill remain, the artery must be still restrained: indeed, the case may be regarded as one to be treated by proximal pressure, the first impulse towards consolidation having been given by the Esmarch cord; or, on the other hand, a second application of the bandage and cord may be deemed desirable. The choice must be regulated by the result of the previous application, and by the effect of the proximal pressure. If the former have produced a certain amount of clotting, which has not dissolved away, the probability is that some little continuance of pressure will effect a cure. If, on the other hand, the elastic pressure have produced no clot, or a very transitory one, the choice lies between recommencement, *ab initio*, of the whole proceeding, or abandoning the method altogether, and resorting to some other means. Herein the surgeon must be guided by the manner in which the previous pressure has been borne, and by the general results of repetition, which will be hereafter given.

If it be determined to use the Esmarch cord again, I would strongly recom-

¹ Lancet, vol. i. 1877.

mend that, unless urgency of symptoms forbid, an interval of from five to eight days should be allowed, during which time such treatment as tends to produce coagulability of the blood may be employed,¹ such as, for instance, the dry diet and low diet system (p. 860).

A consideration not to be disregarded is the state of the heart and its valves, and of the aorta immediately adjoining. It has been suggested, rather than proved, that application of the Esmarch bandage, whether for aneurism or for other cause, might, by over-filling the rest of the circulation, prove dangerous to one suffering from valvular incompetence, or from weakened and dilated aorta. Mr. Gould has suggested that these perils might be obviated by placing a round elastic cord around the other limb, so as to imprison its blood within its vessels. It is difficult, however, to perceive how such an expedient could have the desired effect, since the limb must contain the same amount of blood, whether it be stagnated or no, and the rest of the system, therefore, is not relieved by any withdrawal of circulating fluid, while the vascular system loses the resiliency of the limb vessels—to a certain extent a safeguard against the accident dreaded.

It is evident that the mode in which the Esmarch bandage acts is by mere stagnation. The blood in the aneurism, and in the vessel immediately leading to it, is kept at entire rest; and if it be of such a quality as to easily coagulate, it will do so to a certain extent. The clot thus formed in an hour, or, perhaps, in two, is exceedingly soft, and its cohesion is almost *nil*. Hence pressure must prevent any flow of blood into the artery, and great quietude must obviate any tendency to detachment. It has not unfrequently happened that, when all these precautions have been observed, and when the aneurismal tumor, not pulsating, has appeared completely solid, the condition in the next twenty-four hours has been quite reversed; pulsation has recurred, no sign of any remaining clot has been found, and the aneurism has appeared larger, nearer the surface, and more thinly walled than before. In certain cases, death has resulted; in a few, gangrene.

COMPRESSION BY FLEXION.—The *Écho Médical Suisse* reports in its number for September, 1858, an interesting case of popliteal aneurism, which, a year previously, had been under the care of M. Maunoir, of Geneva. That surgeon observed, during his examination of the tumor, that when the limb was bent, pulsation ceased. Acting on the lines thus indicated, he did not even order the man to bed, but applied a sling in the daytime, and a bandage at night, in such wise as to keep the limb constantly flexed. In a few days the pulsation had greatly decreased; in about eighteen the tumor was solid. A year afterwards, when the above paper was published, only a small, very hard lump remained in the ham.

By one of those singular coincidences which rarely occur, it was in that month, September, 1858, that Mr. Hart observed in a case of popliteal aneurism a like diminution of pulsation on flexion of the limb. He treated the case on this hint by keeping the man's limb bent,² and in about five days the aneurism was solidified. This result led to frequent imitations of the practice, and occasionally with very good effect. It is more especially adapted to aneurisms about the bend of the elbow or in the popliteal space; in other localities it has not been equally successful. The method has also very frequently failed, nor is it entirely devoid of danger. The sort of aneurism in which it is most likely to be valuable, is a small, sacculated tumor whose strong tendency to spontaneous cure is marked by a thick, hard sac, situated either at or just below the ginglymus in the middle of the limb. One or two

¹ Mr. Gould recommends this in all cases.

² Med.-Chir. Trans., vol. xlii. p. 205.

such cases have been cured by mere voluntary flexion in bed. The surgeon may judge if it be advisable to try this mode of treatment by observing whether bending of the limb produce any diminution of pulse; if not, the employment of this method is probably inadvisable. Powerful, or indeed any flexion beyond a very moderate amount, ought not to be attempted, even for experiment, on large, thin-walled aneurisms, since rupture has more than once followed such an incautious proceeding. Over-zealous and too persistent efforts at cure by this means occasionally injure the joint subjected to flexion.¹

ON THE CHOICE OF CASES FOR DIFFERENT FORMS OF PRESSURE.—We may now advantageously pause to consider the advantages and disadvantages of these different forms of pressure, especially for aneurisms about limbs, as also the cases in which they are severally most applicable. It is of course to be understood that the surgeon undertaking to treat a case by these means does not limit himself to the use of one form alone, but will vary or alternate his resources according to circumstances.

Flexion, which is but a mode of pressure, is most successful for aneurisms situated at or below the middle joint of the limb; it probably combines in one, proximal, distal, and direct pressure. It should never be used for a large aneurism in the bend of the hip-joint, lest it rupture the sac. It is not a very potent means of treatment, that is, it will not, or at least will very rarely, benefit an aneurism with thin walls which is still increasing; but if the disease have already considerable tendency to spontaneous cure, that is, if the tumor be hard, and have barely increased for some little time, flexion even very moderately applied may cause consolidation. I have known of more than one popliteal aneurism, the tendency of which to cure was so great that mere rest in bed, with the knee voluntarily kept bent by the patient, has given to nature all the necessary assistance. In choosing the treatment to be applied in any case, flexion suggests itself among others to the surgeon; but I would not recommend this method, unless it should be found that a not excessive degree of flexion stopped pulsation of the aneurism, entirely or in great part. The method may also be used to assist other forms of treatment, as sometimes simultaneously, or better alternating, with indirect pressure, or in recurrent pulsation after ligature.

Indirect pressure (gradual) is also most likely to succeed when a tendency to spontaneous cure is manifested by some accumulation of clot in the sac. The greater the amount of consolidation, that is to say, the harder the tumor, and the more distant the pulsation, the more likely is cure to follow upon pressure. It is not intended to assert that, if the evidence of clot be small, failure must necessarily result, but it is probable that success if attained at all will be long postponed. Before commencing such treatment, we must weigh the probable duration by the above scale against the character of the individual. To employ pressure in the case of an irritable person; of one habitually restless and unable to bear confinement, or to remain long in one position; or of one who is impatient of pain and discomfort, while intolerant of sedatives, would be to court failure. For such persons the *digital* is preferable to the *instrumental* method, the presence of other persons, and the diversion of talk and of constant changes, distracting thought from the sense of discomfort. The frequent intermission of a night for untrammelled sleep and quiet is generally, if the cure be protracted, advisable.

The *rapid method* of treatment by compression is more especially adapted to abdominal aneurisms, whether of the aorta or of the iliaes; to high femoral (inguinal), and, perhaps, to carotid aneurisms—that is to say, to cases in

¹ For further directions as to this method, see popliteal aneurism.

which the tumor is so situated, that either much force is necessary to command the artery or, that the pressure by its mere situation is unbearable. It has also been now and then successfully employed for aneurism about a limb, when the patient, either from constitutional irritability or from recalcitrance, could not, or would not, submit to the pain and restraint necessary for the slower method. In one or two cases a combination of morphia and chloroform has been used as an anodyne, instead of the latter alone.

The *Esmarch bandage* answers best in cases of recent aneurism; nor do I think the presence of clot so great a desideratum as for the treatment by flexion or indirect pressure, though certainly it is no disadvantage. From my experience, I should say that aneurisms of recent formation, which are steadily, but not rapidly, increasing, and which have forcible pulsation, and walls neither markedly thick nor peculiarly thin, are those most amenable to this form of pressure. It should not be employed for large, thin-walled tumors, nor on persons whose arteries are rough and rigid, nor on those with diseased heart,¹ nor on such as have a tendency to either pulmonary or cerebral congestion. For all forms of compression, long fusiform aneurisms are peculiarly ill-adapted.

THE DEFECTS AND DANGERS OF COMPRESSION.—The intention and object of treatment by the various forms of compression are, the avoidance of cutting operations with their risks and other drawbacks. This method was more especially studied and introduced at a period in surgery when such operations, in the absence of anæsthetic agents, were extremely painful, and when the management of wounds, and the presence in them of hempen or silken cords, rendered the tying of arteries a dangerous procedure. But we are not to suppose that any form of compression for aneurism is free from certain very grave objections, which ought always to be present to the mind of him who would thus attempt to cure the disease.

Every form of compression (flexion is included) is *painful*; sometimes, however moderately used, unbearably so—hence the use of narcotics, which some persons, up to a certain point, tolerate well. If the treatment be protracted, it is extremely irksome and wearing, the patient losing both health and strength. The *length of time* during which such treatment may last is very considerable; and although many aneurisms have been cured in from ten, or even less, hours to four or six days and onward, a large number have been thus continuously treated for several months, and in such cases a goodly proportion of the patients have failed to derive any permanent benefit²—a most disappointing result of painful and persevering efforts. A certain tendency to *relapse* remains after apparent cure by pressure. Sometimes this is rapid—that is, within twenty-four hours—sometimes slow, or not till after some weeks. Doubtless this is due to consolidation of the aneurism by soft clot, while the artery remains patent, the blood-stream breaking down and carrying away the partially coagulated blood.

Nor must we consider that pressure is entirely free from *danger*, even when carefully and skilfully employed. We have seen (p. 872) that an occasional immediate effect of proximal compression is rapid enlargement of the sac—a phenomenon which points to the possibility of its producing *rupture*; a possibility, too, which has once or twice been exemplified by actual occurrence. This danger, doubtless, is most imminent in the use of flexion and the Esmarch bandage. *Gangrene* of the limb below, is an event common to all forms of treatment, and, indeed, to all forms of the disease; it may, in some cases, be

¹ Aortic incompetence and mitral stenosis are peculiarly unfavorable.

² Statistics will be given hereafter.

due to pressure on the vein rather than on the artery. *Suppuration of the sac*, especially when the cessation of pulsation has been rapidly produced, must not be left out of sight. *Erysipelas*, with gangrene at the place of pressure, has in some instances followed moderate compression.¹ Even *pyæmia*, although no external wound has been produced, may result;² while Mr. Savory's well-known case shows that *thrombosis* with solidification of the lung, may also follow; and Mr. Pemberton³ gives an instance of the production of *arterio-venous aneurism* at the seat of compression. It is not intended to assert that these accidents are common, or even otherwise than rare, but they must be taken into account; for we have, when we propose to subject a patient to any form of pressure, to consider the possibly protracted treatment, the very considerable uncertainty, the tendency to relapse, and the occasional occurrence of severe, or even of fatal complications.

Another point deserving of very careful consideration is the state of the vessels after the failure of compression, and whether they are left in a state more or less favorable for the application of a ligature. I think that some of those who have expressed themselves on this subject have attempted to answer the question on too broad a ground, and on too general principles. We may, first, consider the result of *proximal pressure*, digital or instrumental, applied for a moderate time, and so as to produce no obvious lesion. If such treatment have been employed, for instance, on the femoral artery, at and a little below the groin, there is no doubt that the collateral vessels will have become enlarged; but this is, in many cases, a detriment rather than an advantage, and may lead to such free flow of blood by the side arteries into the sac, that pulsation rapidly recurs after ligature, and no consolidation occurs. Therefore we may affirm that in persons whose arteries are rigid, either from age or other causes, the effect of pressure on a subsequent deligation, will, undoubtedly, be beneficial, as tending to diminish the risk of gangrene; but that in persons, whether young or old, whose vessels are not stiffened by atheroma or calcification, the effect of unsuccessful pressure will be to jeopardize the result of subsequent ligation, by permitting, through the enlarged collaterals, too ready an influx of blood into the sac.

The same may be said concerning failures of *flexion*, and there seems, moreover, to be, under such circumstances, a considerable tendency to suppuration or rupture of the sac, when recourse is afterwards had to ligature. When, the *Esmarch bandage* proving useless, deligation is employed, there seems also to be some tendency to suppuration of the sac, but the especial danger is gangrene. Unless rapid growth of the aneurism should render immediate measures necessary, some days should elapse between the abandonment of Reid's method and the application of the ligature, in order to allow the vessels, which have been somewhat rudely closed, to recover their elasticity. The artery should not be tied at the spot to which the cord has been applied.

When any form of pressure has produced gangrene of distal parts, the application of the ligature, which will be a necessity if the aneurism continues to enlarge, increases the area of sphacelus.

When gangrene of the soft parts at the place of pressure has resulted,⁴ no

¹ Gay, Subclavio-axillary Aneurism, *Lancet*, Feb. 10, 1872.

² *Bulletins et Mémoires de la Société de Chirurgie de Paris*, quoted in *Lancet*, Jan. 15, 1870.

³ *Med.-Chir. Trans.*, vol. xlv. p. 189.

⁴ A certain number of patients cured by proximal pressure, have suffered from gangrene invading the tissues pretty deeply at the spot compressed. Others, whose integuments have become gangrenous, have not been cured. I consider that to carry treatment thus far is improper; if the case be not cured, or if, as has sometimes happened, a rapid relapse take place, the patient, with a slough over the artery, is in very great peril.

ligature should be applied at that spot; but the vessel must be tied above and below, the ligatures being separated as far as possible without any large branch springing from the artery between them. If this cannot be avoided, the branch must also be ligatured. Even if no gangrene, but pretty severe inflammation of the compressed soft parts, have arisen, deligation of the vessel, at that point, should be avoided.¹ After the use of pressure for some considerable time, the artery is not unfrequently found to be so imbedded in thickened tissues with which its outer coat is continuous, that it is difficult to pass an aneurism needle around it. In some cases, the vein has been very closely adherent to the artery, rendering isolation and deligation exceedingly difficult, and even dangerous.

In conclusion, I would say that since certain operative improvements and the use of soluble ligatures have rendered the operation of tying arteries a far less hazardous measure than it was some years ago, the treatment by pressure ought not to be greatly prolonged, nor repeated again and again after relapses. Valuable as is this method, and desirable as it may be to avoid the knife when feasible, the effects of prolonged pressure-treatment on the health and on the limb are far worse, and no less dangerous, than ligature, while they jeopardize the results of that more potent expedient.² A decision as to the time when failure of compression must be acknowledged, should be founded on the length of time already consumed, and the condition of the tumor. If a few hours have produced some appreciable and real improvement, hope of success may justify perseverance; but if, while the time is longer, the change is less marked, or if complete relapse have occurred a second time, it will be wise, in the large majority of cases, to desist. The collateral branches will have probably already taken upon themselves too much work, and the state of the main vessel will be unfavorable for the further continuance of treatment.

LIGATION.—The first description of tying vessels for aneurism dates from the third century, as far as we know from the writings of the ancients preserved to us; and there is a procedure indifferently called the “old operation,” or the “method of Antyllus,” much talked of and occasionally practised. But, in truth, Antyllus did not describe that which is now done under these names. The only record which remains of the writings of this surgeon, is to be found in the medical collection of Oribasius, the twentieth chapter of whose fourth book is “upon aneurism, taken from Antyllus.”³ We must, in studying this method, remember that the idea of surgeons up to the end of the fifteenth century was that the solidified blood in the sac was the peccant condition—that which rendered the malady dangerous—and that the aim of Antyllus was to get rid of this without causing dangerous hemorrhage. Therefore, after distinguishing between aneurisms arising from dilatation and from rent (probably fusiform and sacculated), he says:—

“If it be an aneurism by dilatation, we make through the skin an incision in the direction of the artery, and separate its lips by means of hooks; then we divide all the

¹ Gangrene of arterial coats is very rarely, if ever, produced by pressure; but cases have, to my knowledge, occurred, in which secondary hemorrhage from the place of ligature (when applied as forbidden in the text) has set in more rapidly than could have happened had the vessel been uninjured.

² I would refer to the history of a case recorded in the Dublin Medical Journal, vol. ix. p. 391. The aneurism was popliteal; the patient, clever and not indocile, again and again protested against continuance of the various forms of pressure, which, nevertheless, were kept up for 720 hours spread over about a month; then the sac sloughed and amputation was needed to save life. It seems to me that such perseverance is a sacrifice to the Moloch of an idea.

³ The work does not pretend to be more than a collection from a great number of previous writers, Antyllus, Galen, Rufus, and many others.

tissues that lie between the artery and the skin; we separate the vein from the artery with blunt hooks, and so we uncover all the dilated part of the artery; then we pass under it a probe with a rounded end, and raise up the tumor. After that we glide along the probe a needle armed doubly with thread, cut the thread close to the needle, so that there are two threads and four ends."

These are then tied, the one above, the other below the dilatation.

"We afterwards open the tumor by a little cut on its middle, so that all its contents may be evacuated without danger of bleeding. But this manner of separating the artery and isolating the aneurism is difficult, and often the force and power of the pneuma drives off the threads. If the aneurism originate in a rent of the artery, we grip in the fingers as much of the aneurism as we can, together with the skin, and we pass under the part so held a needle with a double thread, either of flax or of tendon (*ἡ λίνον ἢ νεύραν*).¹ After pushing through the cord we cut it close to the needle, so as to leave two strings."

These are tied above and below the tumor, which is then incised and evacuated, its greater portion, except that included in the thread, being removed together with the skin; "and thus it is done without bleeding."

The procedure which our writers² on aneurism term the "old operation," and wrongly attribute to Antyllus, is entirely different, inasmuch as in the method still occasionally practised, and which Mr. Syme tried to revive, the sac is opened before tying the artery, which is sought for from within. The procedure is this: The artery is compressed above the tumor sufficiently to annihilate all pulsation; the surgeon cuts through and turns aside soft parts until he reaches or closely approximates the sac, which he opens (or, if the tumor be superficial, he may open it at one cut); he then clears the clot away, and feels for the opening into the vessel, into which he passes a probe. This is to act as a guide to enable him to extend his incision, and to tie the artery above. He then seeks the vessel below, and treats it in a similar way. Afterwards the clots are more entirely cleared away, and the wound is loosely stuffed with lint, charpie, or tenax, and left to suppurate or to slough.

Occasionally, even now, as will be seen when we come to speak of special aneurisms, an operation closely resembling this proceeding is the only means of saving life, and, if the patient escape the exhaustion of the after processes, the aneurism certainly is fully and permanently cured. It is most often applicable in that form of wounded or ruptured artery which is injudiciously named diffuse traumatic aneurism; occasionally when the usual deligation has failed; or when after such an operation, or after flexion or pressure, the sac of the aneurism has burst. But the labors of more modern surgeons, principally directed by Harvey's discovery of the circulation, which led to the perception that the clot in the sac was not a dangerous, but, on the contrary, a salutary condition, have gradually modified the use of the ligature in many ways.

Deligation in the continuity of an artery affected with aneurism, is described as *proximal* (between the tumor and the heart), or *distal* (beyond the tumor). The application of a proximal ligature close to the sac of the aneurism is called the *method of Anel*; its application at a considerable distance, so that one or more branches are given off between it and the sac, the *method of Hunter*. The two differ essentially in their conception and physiological effects. Wherever possible, the latter method is at the present day employed; but in certain localities, as in certain aneurisms of the carotid, subclavian, or

¹ This word may also mean nerve, cord, or the string of a lute. I translate it tendon. Bussemaker and Daremberg, the translators of Oribasius into French, render it "boyaux," thinking, probably, of catgut.

² Except Broca, who has noticed the dangerous and painful operation above described.

external or internal iliac, it may be anatomically impossible to place a ligature at any considerable distance from the sac.

Anel¹ performed the sort of deligation which bears his name in 1710 for an aneurism at the bend of the elbow; he says, "I ligatured it (the artery) as near to the tumor as possible." This operation, not being dictated or supported on any scientific basis, attracted, though followed by brilliant results, little attention, nor does it seem to have been employed for any but small arteries² up to 1785, when Desault tied for popliteal aneurism the artery of that name just above the sac. Doubtless the success of that case, and it must be remembered that the cure of aneurism was at that date exceptional,³ would have led to further attempts with Anel's method of treatment, but that in December, 1785, a patient with popliteal aneurism fell under the care of John Hunter, who, in that same month, subjected him to the new operation which has since been termed the Hunterian method.⁴ Anel's plan, indeed, seems never to have taken any place as a remedy for aneurism of large vessels, and would probably have been forgotten but for the work of Paul Broca.

Now the inherent defects of ligaturing an artery close to an aneurismal sac are many. First, the vessel may at this spot be very deep; second, it is generally very considerably displaced; third, it is (save in recent, traumatic cases) nearly always diseased at the point tied; and fourth, the circulation in the sac is by this operation too completely cut off and suppressed.

The first of these objections may be left for consideration on a subsequent page, as, indeed, may also, to a certain extent, the second: it need only be remarked here that, unless the aneurism be fusiform, the vessel immediately above may be so covered by the sac as to render deligation at that spot impossible. A large popliteal aneurism, for instance, may so fill the whole popliteal space that no part of the artery is accessible between the tumor and the adductor magnus; and it has more than once happened that a proposed deligation of the subclavian has had to be abandoned, because the operator found the vessel so covered by the sac as to be out of reach. Even if this be not the case, displacement of the artery to one side, or into abnormal depths, not only renders the operation very difficult, but invests it with some little uncertainty.

Since spontaneous aneurism, in the third place, usually arises in consequence of arterial disease, the reverse proposition also holds good, namely, that in the neighborhood of aneurisms arteries are likely to be diseased; and this probability is increased by the fact that the change in circulation—the altered condition of parts around—conduces to arterial inflammation. A ligature applied to a diseased artery causes very readily ulceration and destruction of its coats before adhesion and other changes in the interior of the vessel have sealed it and made it secure; hence, secondary hemorrhage is an imminent danger after tying such vessels, perhaps even now; but it was much more so when silk or other non-soluble ligatures were used.

It has, fourthly, been frequently mentioned that the formation of a firm laminated clot depends upon the persistence of a gentle current through the aneurismal sac; but a ligature applied immediately above that spot must

¹ Suite de la nouvelle méthode de guérir les fistules lacrymales. Turin, 1714.

² Heister in his *Institutiones Chirurgicæ* described Anel's procedure, and recommended its application to "reducible aneurisms," whence we may conclude that he, like Anel, considered "that the blood contained in the sac would be dissipated, being allowed to pass on towards the extremity."

³ I need hardly refer to the now well-known phrase of Pott (*Chirurgical Works*, vol. iii. p. 220), "I have tried it [Antyllus's operation] more than once or twice, and I have seen it tried by others, but the event has always been fatal."

⁴ Hunter had long been cogitating the matter, and had by experiments on animals convinced himself of the truth of the principles on which he founded his method.

evidently prevent even the smallest afflux from above, while, if any return current comes to it from below, that flow must be very small and uncertain; the tendency, therefore, after cure by this kind of ligature, will be to the formation of passive clot; or, if, as may also happen, the aneurism remains empty, or nearly so, there is no material which, becoming solid, can obliterate the sac. This seems, on one or two occasions, to have occurred in some fatal cases of popliteal aneurism. In December, 1785, Mr. Hunter, who had long been considering the subject of popliteal aneurism, and the ill results of the prevalent treatment, put in practice his idea of ligaturing the vessel at a considerable distance from the sac,¹ namely, in the space between the adductors, which has since gone by the name of Hunter's canal. In the state of knowledge existing at that time, surgeons were disinclined to trust to a single ligature around the vessel, and Hunter, in this, his first case, used four strings at different intervals, and tied them loosely—hoping that by compressing so large a portion of the artery he might “make up for the want of tightness, as he chose to avoid great pressure on the vessel at any one point.”² The aneurism was cured, but the man suffered from abscess at the site of operation, which arose partly from the locality chosen—deep among muscular and tendinous structures—partly from the kind and number of the ligatures. Shortly after this, Mr. Birch tied a man's femoral artery with “a strong flat ligature,” leaving under the artery another, called the ligature “of reserve.” The man died of suppuration of the sac. In his second case, Hunter used but one ligature. Certainly in some, probably in all, of these early cases, the vein was tied with the artery.

About this time³—the exact date cannot be fixed—Brasdor had proposed placing a ligature on an artery on the *distal* side of the aneurism, and in 1799, Deschamps performed this operation for a high femoral aneurism, with a fatal result. The younger Brasdor, son of the surgeon who proposed this method, was present, and Deschamps speaks of the proposal as “having been made a long time ago,” and adds that Desault thought well of it. It is probable that this “long time” was not more than ten or fifteen years. Some time afterwards, Astley Cooper performed a similar operation with temporary benefit, but ultimately fatal result. In 1815, Hodgson⁴ insisted on the necessary element of success for distal deligation being the absence of any “branch originating from the aneurism, or from the artery below the aneurism,” and above the ligature, and this principle was still more strongly emphasized by Wardrop in 1825. Brasdor's recommendation, and Deschamps's and Cooper's practice, were evidently founded merely on an evasion of mechanical difficulties, in this wise: that when an aneurism was situated on an artery so high up that no ligature could be used above it, the surgeon should try the effect of tying it below; but the essential point, the

¹ In 1793, Deschamps published his “Observations sur la ligature des principales artères des extrémités à la suite de leur blessures et dans les anévrismes, particulièrement dans celui de l'artère poplitée, dont deux ont été opérés suivant la méthode de Jean Hunter, Chirurgien Anglais.” It is, therefore, rather astonishing to find M. Broca, in 1856, claiming this method for Desault, on the strength of his having tied a popliteal artery within the popliteal space, and close to the sac; nor is it possible to repress a smile at this sentence used in describing another case: “With an abnegation, which his English detractors have not been able to appreciate, that great surgeon [Desault], who at that time was aware of the operation practised by Hunter, did not hesitate to adopt the precepts propounded by his illustrious rival.” That is to say, before knowing of Hunter's method, he operated after the manner of Anel; after knowing of it, after the English method, or that of Hunter.

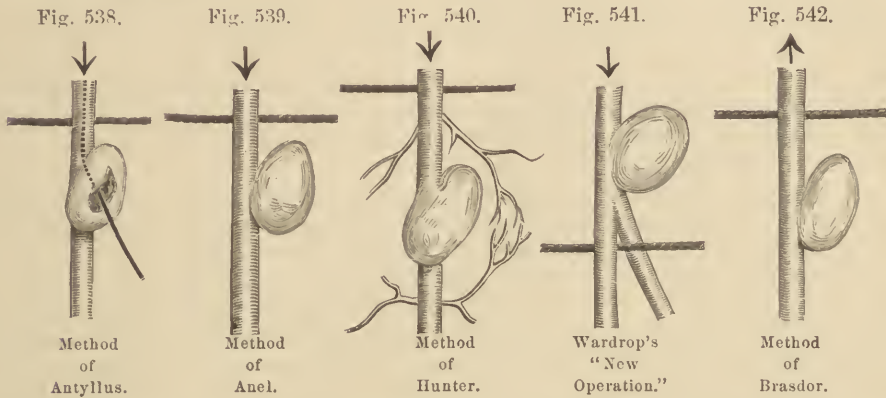
² Home, London Medical Journal, vol. vii., 1786, p. 391.

³ Observations et Réflexions sur un Anévrisme vrai de la partie supérieure de l'artère femoral, par le citoyen Deschamps. Recueil périodique de la Société de Médecine de Paris, tom. v. 1799.

⁴ Diseases of Arteries and Veins, p. 302.

absence of a branch between the ligature and the sac, was not even considered until first Hodgson and then Wardrop formulated that necessary condition.

We may now judiciously pause a while to consider the different methods of ligaturing arteries for aneurism; they are depicted in the annexed woodcuts (Figs 538-542).



[A good deal of confusion in reference to the nomenclature of the distal operations for aneurism, is due to the fact that while, in his original paper,¹ Mr. Wardrop followed Hodgson in laying stress upon the importance of having no intervening branch between the aneurismal sac and the ligature, in his later monograph² he suggested his "new operation," which consisted in the application of the distal method even when such an intervening branch was present, and his famous operation on Mrs. Denmark (case of innominate aneurism) was based upon this principle.]

Hunter's operation for popliteal aneurism was received throughout the surgical world with little less than enthusiasm, and nowhere more warmly than in Italy, where Scarpa, a man of great talent, modified the procedure by tying the vessel still higher in the limb—just where it becomes covered by the Sartorius muscle, at the apex of a space which, on account of his description of it, goes by the name of Scarpa's triangle.

The question of the form of ligature, and whether it should be loosely or tightly tied, or whether the coats of the vessels should be protected by the interposition of a roll of linen or other substance, remained a matter of controversy, and, therefore, of uncertainty, until Dr. Jones published his well-known work.³ The appearance of this much quoted, but little read book, marked an important era in Surgery; it must be again referred to, but at present I only wish to point out that its author proved by experiments that the received doctrine of occluding large tracts of the vessel was erroneous, and that the sealing of an artery depended upon division of its two inner coats, followed by their inflammatory adhesion. He even went so far in his reliance upon this adhesion as to inculcate,⁴ and his teaching was borne out by experiment, that immediately on tying the vessel, and dividing its inner coats, the ligature should be removed, and the wound closed and allowed to heal by the first intention; his object being to eliminate the dangers of suppuration in the

¹ Medico-Chirurgical Transactions, vol. xiii. p. 217.

² On Aneurism and its Cure, by a New Operation London, 1828.

³ A Treatise on the Process employed by Nature in suppressing the Hemorrhage from Divided and Punctured Arteries; and on the Use of the Ligature. 1805.

⁴ Op. cit., 135.

wound, and of slow erosion of the remaining coat. In this somewhat bold proposition, though it found, as we shall shortly see, imitators, the surgical world did not follow him; but the ligation of arteries was much simplified, no other substance, either foreign or natural, in the immediate neighborhood of the vessel, being included in the noose. The almost universal practice was to tie the vessel tightly, and leave one end of the ligature hanging out of the wound. The inconvenience of this foreign substance, acting like a little seton, was felt. Sir Astley Cooper tried a ligature of catgut, in hopes that it might be dissolved or incorporated with the living tissues; his first case succeeded, the wound healed, and nothing more was seen of the ligature; but his second case proved disastrous, and he reverted to the use of the hempen or silk cord.¹

Having now brought the history of tying arteries down to a recent period, we will leave retrospect, and consider the effects of an Hunterian deligation upon the aneurism, upon the vessel, and upon its branches.

We have seen that if an artery is occluded by the ligature immediately above the sac of an aneurism, all blood is cut off from entering the cavity save a slight and very uncertain recurrent eddy; but that when a considerable branch, or several smaller branches, spring from the obstructed vessel between the ligature and the sac, a very different state of things obtains. Let us take a very simple instance: a popliteal aneurism for which the superficial femoral artery has been tied a little below the origin of the profunda. At the moment of drawing the noose tight, the aneurism ceases to pulsate, becoming generally rather smaller and softer; the next effect of cutting off so large an effluent from the parent stem (common femoral), is that more of its current must be thrown on the other channels, especially on the profunda with its circumflex and other branches. The anastomotic channels between these offsets and the derivatives of the superficial femoral below the ligature, permit a certain and a gradually increasing quantity of blood to find its way into that vessel between the ligature and the tumor, and thus a gentle current through the aneurism is soon established, that is to say, the very condition which is most conducive to the steady and gradual deposit of active clot is brought about. By the time that the sac has become filled by this material, the anastomoses in the side channels have so enlarged that blood is carried freely along them to the leg below; even the diminished stream in the tied artery is no longer necessary in maintaining the circulation; and the artery very often becomes occluded by coagulum from the ligature to the aneurism, and beyond it, to the first large branch below, while in other cases a certain portion of that length remains pervious. After a little time the aneurism and the obliterated vessel undergo a process of contraction and absorption, so that they come to resemble a solid cord with a knot on it; and, after a still longer interval, very little or no trace is left of the disease. In the mean time, if a silk or hemp ligature has been employed, the outer coat—the only one really included, since the others have been ruptured and have retracted—must undergo a process of ulceration and division, so as to release the loop of the ligature; the first event is cell proliferation around it—nature's attempt to encapsulate the foreign body. The thickening thus caused, under the continued irritation, soon breaks down into pus, which collects around the artery and in its sheath, and, tracking along the course of the ligature, flows from the sinus-like wound. At first this pus is laudable, but usually, after about ten days, it gets a little stained from admixture of blood; then, in from twelve to twenty days, the continuity of the vessel

¹ Whether Antyllus used some sort of intestine, or another animal substance, is, as we have seen, doubtful, p. 882.

is interrupted, and the loop of the ligature may be pulled without any force from the opening—after which the wound ought rapidly to heal.

All these circumstances—the cessation of pulsation, partial collapse of the tumor, establishment of collateral circulation, lamination of clot in the sac, obliteration of a certain segment of the vessel, and, with some ligatures, severance of the artery—are what should take place, and what we hope for when we perform these operations. The symptoms of these occurrences are as follows:—

Almost immediately after the tumor has ceased to beat, the limb about and below the seat of ligature becomes rather warmer, and usually bedewed with a gentle perspiration. This is ascribed to retardation of the blood stream in the capillaries, consequent on elimination of the propulsive action of the heart. I do not feel much faith in this explanation, because, if the warmth depended upon a partial blood stasis, it should be most marked, or at all events should commence, at the extremity. The contrary is the case: the fingers or toes of a limb whose main artery has been tied, are cold almost immediately after, while the central and upper parts are warm.¹ The warmth may continue for many days; sometimes, indeed, it is continuous, and is accompanied by a slight surface-blush. Generally, in an hour or two the warmth declines, and the limb becomes colder than the rest of the body. These caloric phenomena and their irregularity depend upon the greater or less rapidity with which the blood is driven through the arterioles and capillaries.

After a period also depending on the quicker or slower development of the smaller blood-streams, a numb sense of formication, sometimes amounting to pain, is felt. The extremity, often the whole limb, tingles, and indeed occasionally patients will volunteer the statement that they feel as if insects were running about in the depths of the part. The person has a great sense of weakness in the limb, and does no doubt (as has been seen in experiments on animals) lose power. After a further interval, again depending upon the state of the vessels, and upon the height at which the artery was tied, these sensations more or less gradually decline and disappear. The last to entirely vanish is usually the sense of weakness; the first, unless gangrene set in, is the irregularity of temperature.

The tumor, which at first, on cessation of its beat, became both smaller and softer, continues to diminish, but soon hardens, and in a certain time (from one to twenty hours) may be felt to be quite hard and elastic, sometimes moveless, sometimes having a slight undulatory pulsation, and in other cases (in from twenty to sixty hours) possessing distinct but hardly expansile pulsation,² which after another interval of a few hours again disappears. If previous to operation the aneurism caused pain by its pressure, alleviation is in some cases immediate and almost sudden, but in others is more gradual. Diminution in the size of the tumor is continuous until the swelling entirely disappears, and the period of such disappearance, since it results from absorption of the laminated clot, evidently must depend on the previous size of the aneurism.

These phenomena occur if the conditions have throughout been favorable, but certain circumstances may immediately or more remotely interfere with their sequence, and with the ultimate result, namely:—

¹ I tied the right subclavian of J. S. His fingers became cold almost at once, while for three inches below the elbow the limb was abnormally warm. I made a similar observation on the person of C. M., for whom I tied the superficial femoral. The limb, including the upper fourth of the leg, was, two and a half hours after the operation, hot; below this it was less so, and at the ankle cool, the front of the instep and the toes being cold. This coldness of the toes I had remarked immediately after the operation, and had ordered a foot warmer to be placed in their neighborhood.

² We are here considering the occasional recurrent pulsation which is not incompatible with success.

Anatomical abnormality; excessive freedom of collateral circulation; and vascular rigidity, preventing expansion of side branches.

(1) *Anatomical abnormality*, such as the existence of a double vessel, or a high division of the primary trunk, may at once interfere with the result of operation, by causing continuance of pulsation in the tumor after the ligature has been tightened; or, as has sometimes happened, though the pulsation may cease, and all be considered well, it returns in a few minutes, or in an hour; the aneurism does not solidify; and, if not further treated, it continues to grow.

(2) A similar but generally less rapid recurrence of pulsation and failure of treatment may result from *too rapid enlargement of the side channels*, which indeed may be already excessively developed, either from natural formation, from the check to normal circulation produced by pressure of the tumor, or from the unsuccessful application of indirect compression. We may therefore, after deligation, form the following conclusion: If the recurrent pulsation has commenced after the first hour, and not later, or not much later, than the twentieth, if it remains slight and hardly expansile, and if the tumor continues to be hard, it may be taken as a favorable or at least as a not unfavorable circumstance, since it is evidence that sufficient blood enters the sac to form a good strong clot, and also that circulation enough has been established to eliminate all fear of gangrene. But if, instead of remaining slight, the pulsation increases, more especially if its appearance has been later—from five to ten days or more after the operation—if the tumor again becomes softer, ceases to decrease, or perhaps even increases, however slightly, the deligation for and by itself has probably failed, and some additional measures will most likely be required. Pulsation returning some months after deligation, when the tumor has been some time hard and has sensibly decreased, indicates, as a very general rule, the occurrence of a fresh aneurism in the diseased part of the artery which lies near the original sac.

(3) When the branches of the tied artery, instead of being elastic and dilatable, are *rigid* from disease, or are unduly compressed by the tumor itself, by the diffused blood of a ruptured aneurism, or by improper circular constriction, *gangrene of the limb below the seat of deligation* is likely to ensue. The same event may follow undue exposure of the part to cold, or indeed any too potent application of warmth to an extremity rendered cold by the operation. Therefore it is more likely to occur in old than in young patients, in the lower than in the upper extremity. The higher the operation, the more imminent is this danger; for instance, unless in a subject advanced in years, or in one whose superficial arteries may be felt hard and rough from calcareous or atheromatous deposit, we may tie the superficial femoral with merely a remote chance of gangrene; but if the common femoral, the external iliac, or *a fortiori* the common iliac, be tied, sphacelus may more reasonably be dreaded. It is not a danger confined to deligation: I have known it to follow indirect,¹ and more especially direct pressure.² In some instances, and this may be inferred when the gangrene is unusually moist, it is owing less to arterial causes than to obstruction of the veins, either by pressure of the tumor itself, or by interference with or inflammation of the vein at the seat of operation.

The most usual time for the commencement of gangrene is between the third and fifth, or even up to the tenth day. Late sphacelus, for it may, as

¹ For instance, in Mr. Holmes's case of ilio-femoral aneurism mentioned on page 13 of my monograph on Aneurism (1880), but not as far as I know published elsewhere.

² Gangrene may result, in cases not subjected to operation, from the mere pressure of a large aneurism; hence if artificial compression in the situation of the tumor be added, the risk of such an event is by so much increased.

a rarity, occur even in the third or fourth week,¹ probably is due to phlebitis at the seat of ligature.

The prodromata of gangrene are increasing numbness, and a sense of weight and helplessness in the limb, followed by anæsthesia of certain parts—as the instep or back of the toes—while its further progress is marked by the appearance of a dusky-red or purplish spot, usually on or about the instep or back of the hand, while the toes or fingers become white. Then vesications form, with some œdema, which is especially well marked if the gangrene arises from venous causes. Afterwards the affected and previously red skin blackens, cracks, and gives exit to some blood-stained serum.

Inflammation, suppuration, or sloughing of the sac may occur after the Hunterian ligature, sometimes even a long time after. Their pathology and symptoms have already been detailed (p. 857); their numerical frequency for different vessels will be discussed in the next part of this article. The separation of an insoluble ligature is always a subject of anxiety. The question whether the ends of the severed artery have been sufficiently sealed to resist the force of the circulation, must always be present. This closure of the vessel is produced in part by retraction and folding in of the inner and middle coats divided by the ligature; in part by the adhesion of clot, above and below, to the wall of the vessel. Evidently a short clot, only a few lines long, offers less security than one of considerable length; hence the axiom, much insisted on when ligatures were always of insoluble material, never, unless absolutely obliged, to tie a vessel in close proximity to any considerable offset. To place, namely, a silk or other insoluble ligature on the superficial femoral, immediately below the origin of the deep branch, is to court secondary hemorrhage, by leaving between that offshoot and the ligature too short a space for the firm adhesion of the upper clot.² The surgeon should know for each vessel the average time at which the ligature “comes away.” From the common carotid, subclavian (third part), and external iliac, it drops in from 21 to 30 days; from the superficial femoral, in from 11 to 20 days; from the brachial, in from 8 to 14 days, according to the part tied. As the threads hanging out of the wound keep up suppuration and prevent healing, it is desirable to get them away as speedily as is compatible with safety; but they never must be pulled off so as to sever the vessels by force. The rule of practice is, when the periods above specified have passed, to make gentle traction, and, if the cord do not follow at once, to desist. If after a considerably longer interval the ligature is still retained, a rather stronger pull may be given, since it happens occasionally that, even though the vessel be ulcerated through, the noose of the ligature, hitching in the opening in the sheath, or on some neighboring fascia, is retained. In a few cases threads have from this, or from some other unexplained cause, kept their hold even for months.

TEMPORARY LIGATURE.—The dangers and troubles of a wound are aggravated by the presence of a foreign body twisted around the vessel. The not infrequent mishap of secondary hemorrhage, and the constant fear of such an event as long as the ligature remained, were defects that became only too evident as soon as Hunter's successes caused deligation to be a common operation. Dr. Jones, in his strictures on the action of the ligature, thought that

¹ Dr. Hargrave published a case (Dublin Medical Journal, March, 1865) of gangrene commencing on the thirty-first day.

² This example is chosen as the simplest. Many localities might be named, as the upper half-inch of the external iliac, the upper part of the common femoral, just below the epigastric and deep circumflex ilii, the lower end of the right common carotid, the first part of the subclavian, etc. It is to be noted that some recent experimentalists have thrown doubt on the value of the occluding thrombus, but, as we shall see, on insufficient or misinterpreted evidence.

he saw a way of eliminating these troubles altogether. To him belongs the first idea of the temporary ligature, all subsequent inventions being merely various mechanisms for carrying out his object. He found that when a ligature, or three or four ligatures, were tightly tied round an artery and immediately removed, circulation in the vessel was not restored. From the third to the fifth day, in this series of experiments,¹ the animal was killed (in one instance on the nineteenth day), and all the vessels thus treated were found closed by a firm block of "coagulable lymph," which glued together the wounded inner and middle coats; while outside the vessels a ring of like substance supported and no doubt helped to occlude them. Dr. Jones seems to have possessed no opportunities of testing these results on the human subject, but he infers from analogy that the same consequences would follow like momentary applications of the ligature to the vessels of man, and that the method might be used in certain diseases—notably in aneurism.

Since this time (1805) temporary ligatures have been fitfully used, and many different modes of employing them invented. Travers² tied knots of a description easily loosened, and left the ligatures longer than Dr. Jones had suggested.³ A few cases thus treated ended successfully, but failure was far too frequent. Scarpa⁴ next took up the cause, and showed experimentally that the ligature should remain from three to four days. After this period, an interval occurs, and we then come to temporary ligatures fastened and loosened by some instrument, this being generally a tube, either single and simple, or divided by a partition like a double-barrelled gun, the loop of the ligature projecting through one extremity, and its ends through the other. Other mechanisms are of the nature of forceps, held closed by spring or screw. The names of L'Estrange,⁵ Wolfe,⁶ Porter,⁷ Bruns,⁸ Nunneley,⁹ Dix,¹⁰ Billroth,¹¹ Bickersteth,¹² and many others, are connected with this form of temporary ligature, or its modification, "filopressure." Many of the instruments are both simple and ingenious; the mode of use is to lay the artery bare, pass the thread or wire round it, slide the tube over this, and secure it with sufficient pressure, leaving a means of easy removal. The names of other instruments, such as the artery compressor and canula forceps, sufficiently indicate their nature.

Dr. Fleet Speir's¹³ method, and his instrument, or "artery compressor," are somewhat different, being rather an imitation of torsion than of deligation; they apply to vessels in continuity that rough handling—that, in the French sense, "insult to the inner tunics"—which gives to torsion of severed vessels its hæmostatic quality. His instrument is a tube, of size corresponding to the vessel under treatment, and carrying a sliding arm; one end of this piston-like arm carries a hook, the other a screw and nut. When the artery is bared, the hook is passed under it, and then the screw is turned until the hook and the vessel are drawn into the tube; the pressure thus inflicted ruptures the inner coats rudely enough to make them curl up and retreat within the outer tunica.

¹ Op. cit., chap. iii.

² Med.-Chir. Trans., vol. iv. p. 631.

³ In a deligation of the brachial he had good success (50 hours); in one of the superficial femoral, failure (27 hours). (Med.-Chir. Trans., vol. ix. p. 405.) Roberts cured a popliteal aneurism by leaving the ligature only 24 hours.

⁴ Memoria e lettere sulla legatura temporaria delle principali arterie degli arti, etc. 1825.

⁵ Dublin Medical Press, 1865.

⁶ Canula Forceps, British Med. Journal, vol. ii. 1867.

⁷ Artery Compressor, Dublin Medical Journal, Nov. 2, 1867.

⁸ Zeitschrift der Chirurgie, Bd. v. S. 317.

⁹ British Medical Journal, vol. i. 1868.

¹⁰ Ibid., vol. ii. 1875.

¹¹ Chirurgische Briefe aus dem Kriegslazarethen, 1871.

¹² Medico-Chirurg. Trans., vol. lvi. p. 129.

¹³ New York Medical Record, April, 1871; March, 1872; February, 1873.

The temporary ligature, producing division of the inner tunics, followed by the formation of inflammatory adhesions, certainly possesses the power of occluding the arteries of animals, apparently in every experiment, even though the current is seen to persist immediately after the operation. The theory, as advanced by Dr. Jones, and afterwards supported by Porta,¹ Bruns,² and others, would be, if the arteries of man and of animals acted in like manner, indisputable, but this is far from being the case, as Hunter and Hume found out;³ and we must be cautious in drawing conclusions from these undoubtedly valuable experiments. The temporary ligature has, in a certain number of cases, succeeded, but it has more often failed, either by again permitting free flow of blood, by permitting the formation of an aneurism at the site of operation, or by giving rise to secondary hemorrhage.⁴ The failures are in too large a proportion, the method is unreliable. The instrument of Fleet Speir is the best; the difference between his inner vascular wound and that left by a cord or wire, is similar to the difference between the wounds of arteries torn or cut asunder. Even the carotid has by this device been successfully occluded,⁵ yet the plan cannot be considered entirely secure; and it would certainly appear that one or other of the modes of ligation about to be described must fulfil all the conditions of eliminating the dangers of foreign bodies—allowing healing by the first intention and, at the same time, affording greater security against reopening of the arterial channel by leaving, at all events for a considerable time, a circular constriction upon the vessel.

Soluble Ligatures.—It has been said that Sir Astley Cooper experimented with catgut ligatures with the hope that they might become absorbed or incorporated in the tissues: this hope was not fulfilled, and the matter was over-hastily abandoned; but many years after, Porta⁶ made a great number of experiments with various substances—catgut, silk, hemp, horsehair, etc. In every case he cut the ligatures short and sewed up the wound, killing the animals afterwards at various periods, from four days to forty months. Of 290 ligatures, 64 were entirely absorbed in this order:—

120 silk	.	19 absorbed	.	.	15.8 per cent.
80 catgut	.	33 "	.	.	41.25 "
50 flax	.	10 "	.	.	20. "
40 horsehair	.	2 "	.	.	5. "

The table shows the great capability which dried fibrous animal structures possess of becoming absorbed by or incorporated in the tissues.

Professor Lister, in the pursuit of his aim, the avoidance of putrescent action in wounds, found that by treating catgut after a similar manner to that in which he treated wounded surfaces, viz., by the use of carbolic acid, he could, with the more certainty, cause it to be absorbed. He, therefore, introduced the carbolized catgut ligature.⁷ The material which, on the strength of an experiment on a calf, he first recommended, was thus prepared by him: Take 1 part of pure crystallized carbolic acid, with only just enough water to keep it fluid. Mix this thoroughly by shaking it with 5 parts of olive oil. When the admixture is complete, steep in it the strands of catgut. This

¹ Delle alterazioni patologiche delle arterie per la ligatura e la torsione. Milano, 1845.

² Loc. cit.

³ These distinguished men dissected off all the tunics of arteries in dogs, until the merest film, through which the blood could be seen flowing, was left. In three and six weeks, respectively, repair was complete, without either dilatation or contraction of the vessel. (Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge, 1793.)

⁴ There are many such cases scattered in medical journals. Sands (Philadelphia Medical Times, Nov. 1874), gives four of this last description.

⁵ Bell's case (Medical Record, Aug. 1, 1871), and Fleet Speir's own case of double distal ligature.

⁶ Op. cit.

⁷ Notes on the Ligature of Arteries on the Antiseptic System, 1869.

steeping must go on for at least two months, and is better continued for eight. The effect of this treatment upon the catgut is to render it much more soluble in the tissues; it has been used very extensively for sutures and for ligatures of vessels, both severed and in continuity.

Probably the next generation, or the younger members of this generation of surgeons, will be better able than we are at the present moment to assign its exact value to antiseptic surgery, its high wrought claims, and its evident exaggerations.¹ For myself, I conceive that by its aid we may perform certain operations, among them deligations of large and deep arteries, with greater certainty of obtaining union—if not by first intention, at least without supuration—and this is undoubtedly a very important advantage. Probably the cumbersome and troublesome appliances, the spray, etc., will be very shortly superseded.

Among the various constituents of the antiseptic system, that which chiefly concerns us here is the use of a ligature which, whether it be organized or simply absorbed, does not act within the tissues as a foreign body, but allows the wound to heal, and is not seen any more, if, as doubtless occurs in a large number of cases, all goes on as it should do.

But the results of many cases have produced a certain distrust of this ligature—a distrust which is shared by the majority of operating surgeons, but which was probably first expressed in public by the late Mr. Callender,² and which has been augmented by the reports from time to time of the occurrence of secondary hemorrhage,³ of the formation of a fresh aneurism at the place of deligation,⁴ and of a rapid return of pulsation in, and persistence of, the aneurism;⁵ while my personal want of confidence has been enhanced by the remarkably rapid occurrence of bleeding after tying a common carotid very low down, and by my finding the vessel cut almost completely through. It is not, of course, for a moment to be imagined that carbolized catgut always or generally leads the operator into such troubles; indeed, for tying severed vessels, this material, being a convenient cord ready to hand, will probably continue in use, since it closes the divided mouth of the vessel, and keeps it occluded sufficiently long to fulfil its object in these conditions; but its failures, when used on vessels in continuity, are only too frequent, apparently arising from the fact that its behavior on the tissues is uncertain. Thus a series of careful experiments by M. Arnaud⁶ gives these results:—

Carotid or femoral arteries of dogs tied fourteen times.

Catgut disappeared	once in 4 days.
“ “	twice in 7 days.
“ “	once in 9 days.
Catgut distinctly visible	once in 4 days.
“ “	once in 9 days.
“ “	once in 11 days.
Catgut visible, but softened and infiltrated	once in 16 days.

¹ It must, however, never be overlooked that, just previous to the birth of antisepticism, many British hospitals, metropolitan and provincial, were much infested by pyæmia and other diseases originating in blood-poisoning, so much so that eight years ago a well-known surgeon wrote that what would be best for some of these institutions would be a free use of the pickaxe. (Erichsen, British Medical Journal, January and February, 1874.) The state of certain Continental hospitals has been raised by antiseptic surgery from a very lethal to a favorable one.

² Transactions of the Clinical Society, vol. xi. p. 108.

³ T. Bryant, Trans. Clinical Soc., vol. xi. p. 1; Humphry, British Medical Journal, Sept. 14, 1874; Woods, Lancet, Aug. 28, 1875.

⁴ T. Smith, Trans. Clinical Society, vol. xi. p. 51; Heath, Ibid., vol. xi. p. 40, and others.

⁵ Barwell, Lancet.

⁶ Contributions à l'étude de la ligature dans le traitement des anévrismes. Paris, 1880.

Thus we have such a range of periods within which the carbolized catgut may disappear or remain, that any surgeon who applies such a ligature, must feel a sad uncertainty as to what will happen.

Mr. Lister himself evidently feels that catgut prepared in the way he first recommended has failed to furnish a ligature suitable for tying arteries in continuity, since he has more recently instituted a series of experiments for the purpose of rendering the action of catgut in the tissues more equable and reliable by steeping them in chromic acid;¹ a mode of preparation, indeed, which Dr. Macewen, of Glasgow, had previously employed. But in a case of deligation of the external iliac artery, for which Mr. Lister had supplied the operator (Mr. Pemberton) with a length of chromicized catgut, the ligature came away four months after the operation in an abscess. A piece which the same gentleman supplied to Mr. Bellamy was used for tying the superficial femoral: the wound healed, save a space of about half an inch—a fissure, rather than a sinus—which led straight through the tissues to the ligatured artery. The man left the hospital after three months with this fissure still open.

In the mean time, the general dissatisfaction with catgut as a ligature in continuity caused many surgeons, myself among the number, to make experiments and trials with certain other animal substances, the result being that three materials may now be regarded as probably the best for tying vessels in aneurism. The suspensory tendon of the kangaroo's tail was proposed and used by Dr. Girdlestone, of Melbourne, in 1878.² A Japanese surgeon, Dr. Ishigouro, recommended tendons of the whale, which are strongly commended, also, by Benhenna and Baely;³ while I chose the plan of surrounding the vessel to be tied with its own, that is, with arterial tissue. It does not probably much matter whence the animal tissue employed may come, provided that it be of the fibrous variety, be strong enough to bear a strong pull, be of a consistence that will retain a slight knot, and more especially be *fresh*.⁴ It appeared to me, in studying all the modes of failure of catgut, and experimenting on different samples which I myself had prepared, that the extreme variability depended not on different methods or periods of carbolization, but on certain conditions of its first manufacture, which of necessity involved a certain, or rather an uncertain, amount of putrefaction, so as to allow the outer parts (peritoneum, etc.) to be scraped off with the back of a knife, while the same implement and action squeezed the mucous coat out of the tube under the form of dirt.

Another consideration weighed with me very strongly. I was aiming more especially at a ligature wherewith large vessels near the heart could be safely tied, more especially the innominate and subclavian, the deligation of which, when the patients have sufficiently survived, has always been followed by secondary hemorrhage. It seemed to me that if we could keep a vessel shut up for a sufficient length of time with a ligature that need not ulcerate through the artery, we might (the result of proximal pressure shows it to be possible) cure an aneurism without division of the two inner arterial coats. In other words, it seemed to me that the doctrine of Dr. Jones required revision. Now I found by experiments that round ligatures could not reliably be used, so as to leave those coats entire, but that flat ones, unless

¹ President's Address before the Clinical Society.

² First introduced into Europe by the late Mr. Callender. Clinical Society's Transactions, vol. xi. p. 703.

³ Weekblatt van het Nederlândische Tidschrift voor Geneesk, No. 37, 1878.

⁴ By this term I mean not used immediately on removal from the animal's body, but so prepared and stored that not the slightest taint of putrefaction, no beginning of decomposition, may have occurred.

jerked, or otherwise improperly handled, would always do so. Hence, after many trials and experiments, I hit on the notion of using the strong middle coat of the ox's aorta, and devised the following method of manufacture:—

Procure from a butcher the aorta of an ox (not split up, as is usual, but entire); see that it comes straight from the slaughter-house, and has not been kept; if it can be made into ligatures at once, it is better; if not, place it till opportunity offers in a three per cent. solution of carbolic acid. Strip off the outer coat.¹ The middle and inner coats are then to be cut with a pair of scissors spirally round and round, so as to make the whole into a tape-like cord.²

But in this state the material is too elastic to bear a reliable knot, and it disappears too rapidly, or at least does so in quadrupeds. Both these qualities are eliminated by suspending it and hanging upon it a weight of from one-half to two lbs., such as will stretch it half its own length; two feet of the unstretched should become three of the stretched ribbon. This should be done in an atmosphere warm enough and dry enough to dessicate the ribbon in about five hours, after which, should any irregularities remain, they may be scraped off with a sharp penknife. The material, as it dries, becomes translucent and horny; like vellum, it will keep any length of time rolled up in a coil, but must not be sharply bent while thus dry. I store it in anti-septic gauze under a glass shade.³ About seventy minutes before use, it is to be steeped in a three per cent. solution of carbolic acid, when it becomes perfectly flexible. It also recovers a little of its elasticity, but not an inconvenient amount; indeed, the knot is probably on this account the more secure, because, in tightening, the material by stretching becomes thinner, and, on relaxing, enlarges again, the enlarged part outside the tie acting as a sort of strut against the knot, which thus as it were clamps itself. For passing it, an aneurism needle is required whose eye is slit a little longer than usual.

The cases in which this ligature has been used are not as yet many, but they have all been such as to show the reliability of the material and the soundness of the views above taught; they are:—

- One left carotid.
- Four right carotids
- Four right subclavians } double distal operations.
- One right subclavian alone.
- Two external iliaes (one perhaps was common iliac).
- Five superficial femorals.
- One popliteal.
- One brachial.

In none of these sixteen cases has the ligature given any trouble, being never seen again; all did well as far as the deligation was concerned. Two of the cases should be especially noted. In a deligation of the femoral (by Mr. Bellamy) as the ligature was drawn tight, a little bleeding occurred a short distance above; probably a little branch running into the muscle was torn. At my request the operator passed two more ligatures of the same material

¹ At the upper part this tunic is from one-fourth to one-third of an inch thick, loose and almost spongy; lower down it is thinner and firmer. Care must be taken where the intercostals are given off not to tear the middle coat.

² After a very little practice it becomes easy to keep the ribbon equally broad throughout, or slightly tapering from the upper and thicker to the lower and thinner part; also so to manage the little openings for the small branches, that they do not interfere. I exhibited, at the International Congress (Parke's Museum), a piece of this ligature 36 feet in length.

³ For further details, see the author's monograph, already quoted; also various papers in *Med.-Chir. Trans.*, 1878, 1879, 1880, 1881.

above and below, there being thus three bands in the space of an inch or a little more; this was a severe test, yet the wound healed by the first intention, and nothing has since been heard of the ligatures. The brachial artery of a child, aged nine, was tied on the 19th of June, 1881, by my house surgeon, Mr. Taylor, for consecutive traumatic aneurism of the ulnar artery near the wrist. The ligature used was the stoutest carbolized catgut prepared. Exactly a week after, hemorrhage occurred both at the operative wound and from the aneurism. I examined the former, and found the knot of the ligature lying upon the vessel, but quite loose, the loop having entirely disappeared. The vessel was divided through about one-third of its circumference. I re-ligated with ox aorta ribbon above and below. No bleeding occurred afterwards, and though the wounds had to heal by granulation and suppuration, and though the operation was not antiseptic, nothing was afterwards seen of the ligatures, and the child did perfectly well.¹

At present it is not quite possible to say what ultimately becomes of these ligatures made from animal fibres. Mr. Lister's first idea was that they became organized,² but he has since energetically repudiated this view; probably his denial is correct with regard to catgut, because that material is to a certain extent putrefied, but fresh substances—kangaroo or whale tendon, and vascular coats—do I believe become organized and become part of the body into which they are inserted, for vessels form within them.³

The occurrence most dreaded after deligation of an artery is hemorrhage at the site of ligature. A non-absorbable cord which must divide the artery in order to come away, evidently exposes the patient to this risk. An organizable or absorbable material, if it properly fulfil its object, ought to exempt from this danger, but records which will be presently given show that this is by no means the case with catgut, nor do I think that any form of ligature which severs the middle coat of the vessel can be entirely safe.

The *treatment of secondary hemorrhage at the place of deligation* is not by any means always successful; sometimes a simple pad and bandage suffice to arrest the bleeding, but often the choice of a suitable mode of treatment presents great difficulties. This variability depends on the proximity of the vessel to the heart, on its calibre, on the size of the rent in it, on the number and volume of branches given off immediately above and below the point of ligation, and on the freedom of their inosculation, whereon in great measure the length and steadfastness of the thrombic clot depends. The freedom of inosculation is an important factor, since the bleeding not infrequently comes from the part of the vessel beyond the ligature.⁴

The treatment must in part depend upon the situation of the tied vessel, in part on the amount and rate of bleeding. It is plain that if an artery within or close to the trunk be the seat of hemorrhage, our resources are more

¹ Lancet, July 30, 1881.

² Ligature of Arteries on the Antiseptic System.

³ Space will not permit me to follow here the different views held regarding this organization, this coming to life again, of tissues taken from a dead animal and translated into a living body. Mr. Dent (Med.-Chir. Trans., vol. lxiv. p. 231, and Lancet, March 26, 1881) has shown very clearly that the kangaroo tendon becomes vascularized, and hence we may suppose that it is nourished; and I have had the opportunity of showing several remains of ox aorta ligature at different dates, the oldest, at fifteen months, being inseparably mixed with the surrounding tissues. (Med.-Chir. Trans., vol. lxiv. p. 225, and Lancet, March 12, 1881.) The contention as to whether the actual elements of the materials remain or are replaced by new ones, appears to me unimportant. The latter is the fate in the animal economy of all used tissues, yet the whole organ, though interstitially changed, remains the same. A muscle for instance, after much use, even though a great part of its sarcoous elements may have become effete and have been replaced, is substantially the same and not a new muscle. I have no doubt that many fibre-cells of the organic ligatures are changed for others; but as a whole the material must be considered as persistent. But, as my cases show, these ligatures ultimately diminish in bulk like any other part of the body when their function is fulfilled.

⁴ This is nearly always the condition of secondary hemorrhage after tying the subclavian.

limited than if the bleeding vessel be in a limb at some distance from the body. In the latter case, if the hemorrhage be not a formidable and rapid gush, we may estimate approximately the size of the arterial wound by watching the nature and amount of the flow. If this be brisk but not violent, we may elect either to apply pressure by pad and bandage, or to cut down on the vessel and tie it again both above and below. If the former course be chosen, the thumb should be pressed firmly just above, and afterwards just below, the wound, and at whichever point pressure most effectually checks the bleeding, there should the pad be thickest. Having then made a graduated compress arranged in this manner, it should be held by an assistant steadily over the seat of hemorrhage while the bandage is firmly applied from the extremity up. A few minutes' attention will show whether the bleeding is checked. Even if successful, further precautions should be taken. A tourniquet, or better, if dealing with the lower limb, one of the compressors used for the cure of aneurism, should be applied to the artery above, with sufficient force to mitigate the force of the circulation, yet with such moderation as to render the pressure bearable for some hours. Some trustworthy person must be left in charge, who is frequently to examine the dressings, and who, on any appearance of blood, must screw the instrument tighter and send for the surgeon.

Unless this recurrent bleeding be very slight, it is generally better not to go on with pressure, but if this be continued, another method of application should be used. The wound may be opened, thoroughly cleansed from all clots, and dried, while, if possible, an assistant compresses the vessel above; then bits of perfectly dry sponge or yarn, not bigger than horse-beans, may be stuffed well home into the bottom of the wound, piece upon piece, until the whole is quite full,¹ when, by applying a bandage over the whole, very firm pressure can be made. Another plan is to fill the wound with very small shot, pressed well in till the parts around are prominent. The disadvantages of these methods are the proneness to blood poisoning if the foreign bodies have to remain long, and the danger of recurrent hemorrhage if they are removed quickly. They act by their direct pressure, and by causing the blood to coagulate in their interstices and around the wound in the vessel. I have never had occasion to use shot in this way, and, should the occasion arise, I should prefer a finer, innocuous powder, such as that of oxide of zinc, or of bismuth, through which blood could hardly percolate, and with which some preservative might be mixed.

Any or all of these methods may fail, or it may from the first be deemed better to tie the vessel above and below. The choice must chiefly be guided by the sort and rapidity of the hemorrhage: a severe bleeding is rarely arrested by mere pressure. The length of time since the operation must also have its influence on our selection: if this be only ten days, I think it far better to ligature at once, since, unless it be a very deep one, the vessel is very generally easily found, especially if a large part of the wound be still unhealed. The artery above should be commanded by an assistant's thumb, by a tourniquet, or by an Esmarch cord.² If an undissolved ligature hang out of the wound, it affords a sure guide to the vessel; but in truth a guide is hardly needed, because the original wound only reached to the artery, and if with the finger we clear away the clots and the still soft, newly formed tissues, we must find the vessel at the bottom;³ but it is not very easy to discover the bleeding

¹ In one case, I believed that a certain advantage was obtained by first dropping into the wound three minims of extract of ergot with seven of glycerine.

² If there be time to apply the flat band and cord, much is gained by permitting a good view of the parts.

³ At least this has always been the case when I have had to perform this operation.

point among sodden and swollen parts. A few drops of blood allowed to flow out, may assist the search; or the vessel may be dissected some way above and below the place where it was originally tied, and fresh ligatures be placed a good distance away, above and below. After that, it is well to pass under the artery a blunt hook and carry it down ~~from~~ one ligature to the other to make sure that no large branch springs between the two, for if such a branch be left, bleeding will be apt to recur from the collateral flow; should such a branch be found, it must also be tied. Some surgeons would tie with hemp or perhaps catgut, and divide the vessel between the two knots.¹

Deligation of the artery, *above and below the point of hemorrhage*, sometimes succeeds,² but often fails, the failures being chiefly due to disease of the vessel. Generally the same condition which gave rise to the first hemorrhage causes the second operation also to fail; but sometimes, I believe, suppuration in the wound, by softening the arterial tunics, renders them unfit to bear a new ligature—more especially one that divides the vessel's coats.

Another method may be used if the bleeding come from the distal end of an artery divided, or partially divided, by the ulceration caused by an insoluble ligature. In such a case it is evident that some large collateral branch brings blood from a vessel on the proximal side, along a branch opening into the main channel on the distal side of the wound. This branch may be accessible to a ligature. In this way Smyth, of New Orleans, saved a patient for whom he had tied the innominate, and who had had repeated attacks of secondary bleeding from the distal portion of the vessel. On the fifty-fourth day the vertebral, which brought blood from the brain, was tied; the hemorrhage was arrested, and the man recovered. This method is especially adapted to the branches of the subclavian, but may, in case of urgency, be tried elsewhere, though with less hope of success.

Deligation of the vessel higher up, or of the *main branch* from which it springs, is a device which is not often successful—more so, however, in the upper than in the lower limb, for in the latter such an operation is peculiarly liable to be followed by gangrene, an event which renders the result of the *ultima ratio* doubtful. Hence hemorrhage—after tying, for instance, the superficial femoral—should only be treated by deligation of the common trunk in a person not advanced in years, having fairly sound arteries, and whose limb has not suffered from the first operation.³ In dealing with the upper limb, gangrene need hardly be feared, but when the vessel above has been bared, strict search should be made for any such irregularity as a high division. The original ligature may have constricted the aneurismal vessel, and yet, when the side-channels have become enlarged, an aberrant branch from the other portion of the artery may carry blood into the aneurismal portion close to the place at which it was tied. In certain cases all these devices, one after the other, fail, either from some inherent defect of the vascular system, analogous to that which produces hæmophilia, or because the arteries of the part have been damaged by previous treatment.

CASE XV.—As an instance of such ill results I may quote a case which occurred in the practice of Professor Agnew: A popliteal aneurism was treated successively by the Esmarch bandage, pressure, flexion, and then by ligature of the superficial femoral;

¹ I do not recommend such a division if the flat ligature be used, as I do not feel confident, since it does not bury itself in the arterial tissues, that it holds upon a divided vessel; it might—I have never seen such an occurrence—but it might be pushed off by the force of the current, or the retracting vessel might withdraw itself from the noose.

² See Humphry's case (British Medical Journal, 1876, vol. x. p. 591) and my own case (Lancet, August 3, 1881), referred to at p. 895.

³ This observation cannot hold in regard to the external and common iliac, because in cases of hemorrhage from these vessels we cannot amputate, and to tie them may be our only resource.

on the ninth day there was hemorrhage from the wound, and the vessel was tied above and below; in a week, bleeding recurred, and was found to come from the profunda; this vessel was ligatured with the same result; the common femoral, the external iliac, and the common iliac, were then tied, one after the other, each time for reiterated bleeding. Then an unnamed, enlarged branch, overlying the common iliac, and afterwards the obturator and epigastric arteries, were tied. The man succumbed to repeated hemorrhages.¹

Hence it is prudent, if, after tying in the wound has failed, deligation above be employed, to avoid going so high as to deprive the patient of the last life-saving chance—amputation. If the third deligation high up in the limb fail, it appears useless to go higher—into the trunk, for instance. If that be done, life literally hangs on a single thread.

To sum up, *amputation* is, when situation permits, sometimes the wisest and the safest course, especially in the lower limb; as when, after the primary deligation, the parts below have been long in recovering circulation, or have barely recovered it at all; when, in the course of that procedure, the vessel has been found diseased; when the deligation, though producing hemorrhage, has not cured the aneurism; or when, after apparent cure, signs of inflammation or suppuration of the sac have set in.

When deligation at the wound has proved futile, and the patient has lost much blood, tying further up is rarely useful. Still less when a higher ligature has failed should it be repeated; and most certainly not if the third ligature must be in a place that would preclude amputation.

Amputation for secondary hemorrhage is rarely necessary in the upper limb, since the vessel—or, if necessary, more than one vessel—may be tied with little risk of gangrene. In the lower limb, the ligature placed on the vessel above is frequently followed by gangrene. Since that result would necessitate amputation, the surgeon may resort *ab initio* to this operation with the less compunction after all reasonable means, that is, all that do not evoke more dangerous complications, have been tried.

Suppuration of the aneurismal sac after a lengthy interval—about or over two months after treatment by pressure or ligature—is not usually accompanied or followed by hemorrhage. It is very rarely thus complicated if, among the local symptoms, pulsation be not included. When, on the contrary, the phenomena about to be described present themselves within two months of such treatment, which may have been apparently quite successful, bleeding generally ensues, especially if pulsation has returned.

The symptoms are very similar to those of an ordinary acute abscess. The patient, up to this time progressing favorably, experiences *malaise*, perhaps has one or more rigors, and is restless and feverish, with a temperature of from 100° to 102° Fahrenheit, or even higher. The tumor, which was getting smaller at first, ceases to decrease, and after a little while becomes markedly larger. It is painful, often intensely so, and usually hot; in a little time it fluctuates, or at least the surrounding tissues do so, and the skin becomes of a dusky red. The addition of pulsation is a grave complication. If the swelling burst or be incised, discolored pus, often fetid, and after a time coffee-colored or plum-colored, is evacuated; deep purple and grayish detritus follows. Sometimes immediately after, a few drops, or perhaps a stream, of bright arterial blood issues from the wound; in other cases this flow is delayed for a few hours, or even for a few days; in some cases, especially in those in which the suppuration has been long delayed, hemorrhage may not occur at all, but it is to be dreaded as long as the wound discharges grumous matter, or has not become filled by healthy granulations.

¹ Philadelphia Medical Times, Nov. 10, 1877, p. 56.

It nearly always occurs immediately, if, while swelling, the tumor also pulsates pretty strongly.

The treatment, therefore, of a sac suppurating after deligation, is to seize a favorable but early moment for incision. It never should be allowed to burst, lest, in the absence of skilled assistance, the patient die of hemorrhage. Neither should opening the tumor be hurried, or performed without due preparation, and without having such appliances in readiness as may be necessary for further measures. A tourniquet should be applied loosely above the sac, before the incision is made; on no account should the abscess be kneaded or pressed, after it is opened, but it should be simply covered with a cold wet cloth; if no bleeding follow in fifteen or twenty minutes, the patient may be left to the care of some well-instructed nurse or assistant, who should be instructed to screw the tourniquet home on the first appearance of bleeding. After the first twenty-four hours, the danger of hemorrhage greatly diminishes, though as long as shreds of clot, purple or fleshy lumps, come away, absolute security is not attained. If a little bleeding follow the incision at once, or arise shortly afterwards, the finger should be gently introduced, and all the soft, broken-down matters which come away easily should be abstracted. A solution of carbolic acid, 5 per cent., mixed with an equal bulk of the liquor ferri perchloridi, may then be poured in, and after a few minutes the chasm left by the evacuated matters may be stuffed somewhat tightly with lint or tenax, while pressure is kept up by a bandage.

If from the first or at any subsequent time the bleeding be more severe, the best practice is to empty the sac in the manner described in speaking of "the old operation;" then, looking at the now naked wall, the surgeon must discover the source of hemorrhage. This may be the vessel above or below, or some side channel opening laterally into the sac, or, again, the blood may come away from innumerable orifices after the manner of general oozing.

In the last event some styptic, such as ice, the perchloride of iron, or the chloride of zinc, combined with direct pressure and the internal use of ergot—perhaps the actual cautery—may prove effectual. Proximal digital pressure should be tried while the wound is under watch, and if it check or greatly diminish the bleeding, may be used alone, or together with direct compression.

If a distinct bleeding orifice be perceptible, the vessel leading to it should be tied with one of the ligatures that do not divide the arterial coats. This operation is, if the opening belong to the main vessel, precisely like the "old operation" already described (p. 882); but if the bleeding spring from an enlarged collateral branch that runs into the sac from the depths of the limb, the procedure is even more difficult. It is presumed that the opening in the sac has been made wide enough to afford a good view, and therefore probably to give room for work. Into the bleeding orifice a probe must be passed, and around it, at a few lines' distance, an incision should be made with the scalpel deep enough to give a good hold to a pair of forceps, which now can seize the parts around the bleeding orifice and permit a ligature to be thrown around them. If the part be very deep, however, this is impossible; but a thread of silk or hemp may be armed with semicircular needles at both ends, and with a needle holder each may be passed in a different direction half around the orifice, at a sufficient depth to insure that the thread entirely surrounds it.

A second deligation nearer the sac may be attempted; especially if pressure so severe, or in such a situation, as to be insupportable for a sufficient length of time, be found to arrest the bleeding. If all fail, amputation is the only resource, and this should not be delayed until the patient is greatly

exhausted by loss of blood. As in secondary hemorrhage from the site of deligation, so in bleeding from a suppurating sac—more especially if in the lower limb—gangrene is very apt to follow the renewed application of ligatures.¹

Most of the mortality from suppuration of the sac after ligature is due to hemorrhage. There are, however, other dangers, viz., exhaustion, hectic, and blood poisoning; these must be combated on those principles which are detailed in other portions of this work.

Gangrene of the limb after ligature does not materially differ from certain forms of gangrene from other causes, as for instance from embolism or from arterial disease, so that it will not require any separate description or recommendations for treatment in this place.

It has been said (p. 888) that occasionally, after the application of a ligature, *pulsation*, having for a time been annulled, may return; and several modes of recurrence, as immediate, early, and late, have been enumerated. Immediate, recurrent, or continuous pulsation is often due to anatomical abnormality,² which should at once be investigated; but if very slight, it may be the consequence of a previous attempt at cure by pressure, which has too greatly enlarged the collateral vessels. Early recurrence—that is to say in from twenty-four to forty-eight hours—is, as a rule, due to large collaterals, and, therefore, is more common at those places where normal inosculations are large. Unless the pulsation be considerable, its prognosis is favorable, but not if the aneurism beat as strongly, or nearly as strongly, as before the operation, and if it continue to increase.³ Recurrence in about a fortnight offers a less favorable prospect. Secondary aneurism, that is, a new sac, arising close to the site of the former tumor (a somewhat rare event), either manifests itself shortly after the patient begins to move about, or some months afterwards. In all these circumstances, save when very slight pulsation occurs within forty-eight hours, a pad upon the aneurism, secured by a moderately tight bandage, should be employed; the extremity must be watched lest gangrene be produced. The limb may be raised, and if it be the lower one—especially if the aneurism be popliteal—flexion may be employed. Pressure (digital, in preference) may be applied above the place of deligation. Cold, applied by means of ice, has been recommended, but must be used with the greatest caution. If the ligature have given way, the vessel should be tied again with the ox aorta ligature, above and below the seat of primary deligation, or the vessel may be thus doubly retied with hemp, and divided where the first ligature was placed.

INDICATIONS FOR AND AGAINST DELIGATION.—These may, in part, be gathered from the above account of its failures and its dangers. The circumstances which should deter from operation may be such as affect the system, or, at least, the circulatory system, generally, and such as belong to the particular vessel involved, and to the aneurism.⁴

Heart disease, namely, mitral or aortic incompetence, if well marked, would negative ligature, especially of a considerable vessel; slighter affections of the same sort would not do so. A very weak heart, believed to have thin

¹ Some writers have spoken with despair of tying vessels leading to a bleeding, suppurating sac. I believe that the newer forms of soluble ligature place this matter on an entirely different footing from that which it has hitherto occupied.

² That is to say in proximal, of course not in distal deligation.

³ Some cases of recurrence from failure of the ligature are noted at p. 892.

⁴ It is presupposed, in the ensuing paragraphs, unless stated to the contrary, that the aneurism is not in a condition very rapidly to destroy life, and that other measures have been either tried, or for some good reason rejected.

walls and to be fatty, as also lung congestion from valvular disease, would form strong objections to deligation—the latter condition, more especially, if a large artery about the neck were in question. General *atheroma*, or the same condition if well emphasized, even though confined to the aorta, would furnish a contra-indication, and again more particularly about the neck, or if so large an operation as tying the abdominal aorta or the common iliac were in question. *Aortic aneurism* should negative deligation for external aneurisms.

Local disease of the artery about to be tied, would certainly deter as long as one could hope that life was not immediately threatened by the progress of the disease. At the same time I must state my belief, borne out by experience, that a vessel, even though considerably atheromatous, may be successfully tied if a ligature that need not cut the arterial tunics be used, and if care be taken not to cut them. Probably, however, extensive calcification would not allow any ligature to be safely used at the degenerated parts.

Conditions of the aneurism itself which would negative the Hunterian deligation are described by some writers as very many. Rapid growth, thin walls, and forcible pulsation, do not, however, in my opinion, forbid deligation. It is true that suppuration and bursting of the sac may occur, especially if the tumor be surrounded by loose tissues, such as those of the axilla; but if these cases be left to themselves, rapid, if not sudden, death is inevitable, whereas after ligature the sac may not burst, and, if it do, hemorrhage will be less severe and more easily restrained, since the main channel is cut off. The patient, or his friends, should know, however, that the chances of failure are in such a case considerable. The artery should not, under these circumstances, be tied at a great distance; sometimes indeed, as in axillary aneurism, it cannot be so ligatured; hence the surgeon, before proposing the operation, should ascertain that the part of the vessel which he wishes to reach is not aneurismal, and that it is not covered by the sac springing from a place further on.

When the limb beyond the aneurism is œdematous, application of a ligature to the main artery is apt to be followed by gangrene. Whether or no the knowledge of this fact should preclude deligation, depends on many circumstances:—

If the aneurism be growing quickly, while its walls are becoming thinner, so that its ultimate rupture is a mere question of days, the ligature may be, and often is, the only chance of saving life; it is true that amputation may afterwards be necessary, and that the patient must then pass through another ordeal, more or less dangerous; but life may be saved.¹

If the aneurism, which may have been increasing, have ceased, or nearly ceased, to grow, it will be well to investigate the cause of the œdema; it may arise simply from pressure on the vein, or it may be that form of subcutaneous and subfascial swelling which is only the first step of a widespread and rapid gangrene. The distinction between the two conditions is to be found in the state of the smaller veins, and in the temperature. A cold insensitive limb, white and bloodless, shows that want of passage through the artery is causing, as it were, death by starvation;² while, on the other hand, a more marked and deeper swelling, with a high red or lurid coloration,

¹ I would refer here to a case thus already mentioned, under the care of Mr. Holmes; the man had ilio-femoral aneurism: after pressure, gangrene of the leg supervened, but, nevertheless, that surgeon and all his colleagues thought it his duty to tie the external iliac; in this view, I, being present, agreed. After deligation with the ox aorta ligature, the aneurism became solid. I do not think that the gangrene increased much in extent; the limb was amputated a little above the knee; and the man is now alive and well.

² Occasionally parts, more rarely wide tracts, of such a limb are hyperæsthetic.

marked by a meshwork of large full veins, shows obstruction, not to the onward, but to the returning current.

Whether or no, in the former of the above states, the artery should be tied, must be decided by the condition of the aneurism: when that sort of gangrene sets in, very rapid, almost sudden solidification sometimes takes place. It is therefore wiser to temporize, unless the sac be getting thinner and larger.

In the second condition, it is also as a rule best to endeavor to reduce or diminish the swelling before resorting to the ligature.

In certain cases, much of this venous engorgement may be removed by adopting one or all of three measures: (1) Change of position, which by altering the place of the sac obviates the pressure; (2) Elevation of the limb; (3) Careful, not too firm bandaging, frequently renewed.

After a time, and whether or no these means have succeeded, the artery should be tied, partly because by that means the amount of blood passing to the over-filled limb is diminished, and partly because the aneurism will probably decrease and allow the vein to resume its function.

Allusion has already been made (p. 889) to the place of deligation in regard to branches given off from the main vessel. Had the principles of thirty years ago, viz., never to tie near a large branch, been rigidly adhered to, very few vessels of the body would have undergone deligation. But the extent of the internal clot, important as it is with ligatures that must come away, is perhaps less so with those that are left around the artery, and probably (for I must speak with a necessary lack of experience, which time alone can give) ligatures which remain on the vessel, and do not divide its inner coat, are secure against secondary hemorrhage, whether or no a thrombus form. If this view be correct, no part of a vessel accessible to ligation at all, can be unsuited for that sort of band. Nevertheless, when circumstances permit a choice, prudence would forbid deligation to be practised very near to some great branch.

ANEURISMS OF THE LOWER EXTREMITY.

The terminal vessels of the extremities are rarely aneurismal unless from direct wound,¹ and the vessel least uncommonly affected by this condition is found to be the dorsal artery of the foot, the disease occurring here, probably, as the result of pressure by an ill-fitting boot, or of sprain, and sometimes as a sequel of gunshot injury by a spent ball which has merely bruised the part. Less frequent are aneurisms in the sole of the foot, and behind the malleoli, more especially the outer.

ANEURISM OF THE DORSAL ARTERY OF THE FOOT.—This is a far more serious disease than the size of the vessel would seem to warrant; nor is its cure by any means easy. This is no doubt owing to the free communications which exist between the three vessels that nourish the extremity, so that the sac is probably in connection with more than one artery, and may lie, as some dissections have shown, partly between the bones.

The cases are not very common: I have been able to collect eighteen, four of which followed direct wounds, while three were ascribed to sprains, and four were classed as spontaneous; in the records of six no mention of casualty is made.² The tumor is usually situated over the scaphoid or internal cunei-

¹ I have excluded the erroneously named traumatic diffuse aneurism, but a few such cases are on record.

² Fourteen of these cases are cited by Delorme. (*Gazette Hebdomadaire*, No. 9, 1879). Of these the earlier ones are taken from very short and unsatisfactory notices. Two more are in the *Zeitschrift der Chirurgie*, Bd. xii. S. 477. One is in the *Philadelphia Med. Times*, March 21, 1874; one in the *Brit. Med. Journal*, Dec. 8, 1870.

form bone; the further forward its place, the more likely is it to be serious and difficult of management, as, when it lies at the root of the metatarsus, the branch communicating with the plantar arch is likely to be involved, and some part of the aneurism will then be interosseous. The size is usually about that of a hazel-nut; but it may reach that of a bantam's egg. The following table shows the result of treatment in the fourteen cases the management and fate of which have been ascertained. It will be seen that pressure succeeded, although with difficulty, twice, and failed seven times; in two of the unsuccessful cases, death was the direct result of the treatment. Ligature, either above, or both above and below, was practised seven times: three times after failure of pressure—in these cases a successful result followed—and four times primarily; in two of these, simple deligation was followed by opening the sac and amputation; in one, simple failure is recorded; in another, death followed. Coagulating injections were employed twice, and each time successfully. Opening the sac was practised four times, and the end in all but one case was death.

Treatment.		Result.	Cause of death or amputation.
Failure	Success.		
Ligature above and below	Death	Gangrene.
Pressure indirect	Pressure severe	Cure	
Pressure indirect	Ligature above	Cure	Gangrene and rupture of sac. Gangrene and hemorrhage.
Ligature and opening sac	. . . . .	Death
Pressure indirect prolonged	. . . . .	Amputation
Pressure indirect	Ligature above	Cure	
Pressure indirect	Ligature peroneal ¹	Cure	Gangrene and hemorrhage.
Ligature above	Coagulating injection	Cure	
Esmarch. Pressure. Open- ing sac	. . . . .	Failure ²
	. . . . .	Death
	Pressure direct and } indirect	Cure	Hemorrhage.
Pressure. Opening sac	. . . . .	Death
Esmarch. Several times	Coagulating injection	Cure	Survived. ³
galvano-puncture		Cure	
Ligature. Opening sac	. . . . .	Amputation

The inferences are, if we accept the teaching of so small an experience, clear: Not to open the sac, not merely on empirical, but also on anatomical grounds. To employ direct pressure, which at this part is very painful, tentatively only; and unless it bring marked amelioration, not to continue it very long. Indirect pressure at this part is exceedingly painful, nor is any form, save on the femoral, capable of controlling pulsation. I would suggest the use, with or without an anæsthetic, of the Esmarch bandage, applied in the erect posture that the sac may be full—the tumor being omitted from the coils of the bandage—followed, after an hour, by instrumental pressure with Signoroni's tourniquet on the femoral, alternating with digital pressure on the dorsal artery as it passes over the margin of the trochlea astragali. In case these fail, the choice lies between coagulating injections and the ligature. Now no part of the body could be better adapted for the use of a coagulating fluid than the dorsum of the foot—there being so little beyond the sac which could be injured by its action; nevertheless, the arteries beyond must first, if possible, be occluded, and the femoral above restrained—the sac should be

¹ In this case the surgeon cut down on the anterior tibial, but could not discover it, finding two veins (?) instead.

² Patient left hospital with tumor still pulsating.

³ The sac did not apparently need to be opened.

well filled. The injection has been relatively more successful than the ligature; but some of the failures of the latter occurred at a time when the elements of safety in such operations were but ill understood. My personal predilection would be, after sufficient trial of pressure, to tie the artery above and below; if after a week pulsation continued, to use cautiously an injection of the weaker formula given on p. 863.

Should this fail, a further choice lies between an amputation (Chopart, Syme, or Pirogoff, according to the situation of the aneurism) and deligation of the posterior tibial. If after the anterior artery has been tied, the persistent pulsation can be commanded by pressure behind the inner malleolus, the latter course should be chosen. I am hardly prepared to advise ligature of the common femoral, and do not think that good would result from tying the superficial branch.

I am not aware of any instance of aneurism occurring at the *outer side of the foot*, nor of any case in which the *peroneal artery* has been tied for such a disease, except the curious instance embraced in the above table, in which some anatomical peculiarity appears to have been present.

PLANTAR ANEURISM.—In the *sole*, when aneurism occurs, it involves the external plantar artery, and is usually situated over the cuboid bone, or sometimes at the base of the first metatarsal bone. Here again the presence of communicating branches causes some difficulty in treatment, which must be conducted on the same lines, *mutatis mutandis*, as that of aneurism of the dorsal artery.¹

ANEURISM OF THE ANTERIOR TIBIAL.—The anterior tibial artery rarely becomes aneurismal. When it does so, the disease occurs usually over the flat surface of the tibia, just above the ankle-joint; or high up, just below where the artery perforates the interosseous membrane. I do not know of this vessel being affected in the middle of the limb.

Both forms of the disease are generally curable by the Esmarch bandage, or by acute flexion of the knee. The high form is more amenable than the lower to indirect pressure on the femoral. I would recommend the trial of these three measures, in the order mentioned. The two latter should be at first only tentatively employed. If flexion do not either completely or very nearly arrest the pulsation, it should be discontinued. If after from 16 to 24 hours, pressure on the femoral, spread over three days, do not effect material improvement, it will, probably, fail even on longer application. These efforts should not be carried as far for the low as for the high variety, since tying the anterior tibial in the lower third of the leg is a very simple operation, which should also be very safe, but which is only efficacious when the aneurism lies low in the limb.

Deligation of the Anterior Tibial Artery in its Lower Portion.—This vessel might be marked out on the surface by a line running from the upper tibio-peroneal articulation to a little inside the centre of the ankle-joint. It lies throughout its course in contact with the outer aspect of the anterior tibial muscle, and may best be exposed by making an incision through the superficies just outside the tendon of the same name. By pressing the edges of the cut aside, with either the finger or the handle of the knife, the deep fascia is sufficiently cleared to show the inclosed parts marking it with white lines.

¹ A case of this aneurism, cured in four days by pressure on the anterior and posterior tibial, and direct compression of the tumor, is quoted in the Boston Med. and Surg. Journal. Jan. 29, 1874.

On the outer side of that broad line, which the anatomist at once knows to be the anterior-tibial tendon, the fascia is to be slit up, exposing a little space between the above-named tendon and that of the extensor proprius pollicis; and in this space the artery is easily seen, with the nerve, unless the incision be unusually low, on the outer side. The artery is here surrounded by two companion veins and their cross-branches, which are bound to it by a thin, sheath-like fascia; and the operator may, if he will, separate these with the eye-end of a probe, or with an aneurism needle; but he will then probably break some of the communicating offsets, and I think it better, upon the whole, to include the companion veins in the ligature.

Ligature of the anterior tibial artery above the lower third of the leg must be very rarely required, and then for wound rather than for aneurism. The operation is performed in much the same way as that just described, but the vessel lies deeper, though in the same relative situation with regard to the muscle of like name. This operation is hardly practicable in the upper third of the leg, since the vessel pierces the interosseous membrane from $1\frac{1}{2}$ to 2 inches below the tibial tuberosity. The surgeon operating at some point in the middle third of the limb, feels the crest of the tibia, and, estimating the breadth of the anterior tibial muscle, makes a longitudinal incision at that distance from the bone, and, using his finger, clears the deep fascia. He now holds the wound open, and moves it from side to side until he recognizes the whitish-yellow line that marks the offset of the intermuscular septum between the anterior tibial and the extensor longus digitorum;¹ and here the fascia is to be split up. Generally the blade of the scalpel may now be laid aside, and the handle used to separate the muscles. In doing this, the operator must be careful to keep the instrument next to the anterior tibial muscle, and to turn the extensor proprius outwards with the common extensor of the toes. It may be that he will come to the region of the artery—may even see the nerve overlying it—and yet cannot encircle it by a ligature, because it lies in a separate compartment of the intermuscular septum; if so, a few cautious touches of the knife must open up this sheath till the nerve is bared, when, by drawing this outward, the artery with its encircling veins is exposed. Artery and veins may then be surrounded by the ligature, which is most readily passed, either with an eyed probe properly bent, or with an aneurism needle having a sharper curve than usual. There is no difficulty in the operation beyond the depth at which the vessel lies; and this, since no important part lies between the artery and the skin, should be no impediment to its performance. The secret of facility is to carefully avoid dividing, and going astray among, muscular fibres which should be left quite intact.²

ANEURISM OF THE POSTERIOR TIBIAL ARTERY.—This is less uncommon. I find in a period of ten years, four cases recorded.³ [Dr. R. A. Kinloch has tabulated⁴ twenty-two cases of spontaneous aneurism of the posterior tibial artery, including one of his own, with seven deaths and fifteen recoveries.] Spontaneous aneurism of this vessel occupies usually the upper half of the leg, attains a considerable size before it makes its presence known, and forms a considerable tumor, lying at the back of the leg, rather on its inner aspect,

¹ Unless the incision be quite in the lower part of the middle third, the extensor proprius pollicis will not have come to the front.

² The rarity of these cases may be inferred from the fact that I find in the last ten years but one case recorded. (Medical Times and Gazette, April 11, 1874.) Mr. Erichsen failed to cure this case by digital and instrumental pressure, combined with ergotin injections. The man passed out of observation, declining further treatment.

³ British Medical Journal, January 27, 1872; Lancet, May 20, 1873; Philadelphia Medical Times, September 25, 1875; Dublin Journal of Medical Science, September, 1877.

⁴ American Journal of the Medical Sciences, July, 1882.

and projecting in the same direction. The disease is generally amenable to indirect pressure on the femoral, because the chief artery having a little above divided into three main branches, the current in the sac can hardly be powerful. Nevertheless, the cure does not appear to be rapid. It is probable that the Esmarch bandage would have considerable effect; and since, as above explained, the circulation in a sac supplied by a vessel of the size of the posterior tibial, could hardly be very powerful, it would scarcely be necessary to draw the cord very tight. Should these means fail, and should either surgeon or patient desire to avoid the use of the knife, injection with perchloride of iron might be employed; otherwise, unless the sac be placed too high in the limb, deligation of the affected artery may be practised; or, if it be too high, deligation of the femoral, either in Hunter's canal or in Scarpa's space.

Ligation of the Posterior Tibial Artery.—Two methods of doing this have been devised: The one—commonly called the “old method”—by an incision near the posterior edge of the tibia; the other, by a long wound in the middle of the calf, through the gastrocnemius and soleus. This last is called Guthrie's method, he having devised it because he had found some difficulty in the other mode.¹ I presume that in the instance or instances in which Guthrie experienced trouble, some severe spasm of the muscles, perhaps some anatomical abnormality, produced difficulty; for the fact is, that, in all the lower three-fourths of the leg, deligation of the posterior tibial artery through an incision behind the tibia is very easy, and few operations less deserve Guthrie's epithets—difficult, tedious, bloody, and dangerous²—while to the method which he substituted, such terms might be not unjustly applied. Indeed, Arnott's patient bled freely, and had much cramp and pain.³ In two instances I have practised the incision here recommended, in order to stretch the posterior tibial nerve for certain painful conditions of the foot. In both I was able to feel, and could readily have passed a needle around, the artery. Barely a drop of blood was lost throughout the one case; in the other I felt what appeared to be a tumor of the nerve, and in using the handle of the scalpel to isolate that cord more completely, a sudden spurt of arterial blood showed that the vessel had been torn. I had no difficulty in passing beneath it an aneurism needle, doubly armed, and in tying the artery above and below the little rent.

Guthrie's operation may be thus described: An incision, six or more inches long, is to be made in the middle of the calf, and the junction of the lateral halves of the gastrocnemius exposed; the separation of these brings the soleus into view. This muscle is also to be severed in the same direction, the operator assuring himself that the whole thickness is divided by noting the easily recognized surface of the deep fascia. The wound through skin and both muscles, held agape with broad retractors, is moved slightly towards the inner side until the whiteness of the nerve is seen through the fibrous tissue, or until its round cord can be felt, with perhaps the pulsation of the vessel beneath it; along this line the deep fascia is slit up, when, the nerve being drawn outward, the artery, with its veins, comes into view. Some difficulty, owing to the depth of the wound, will, in large limbed persons, be experienced in passing the ligature.

Division of the muscular structures causes the incision to constantly fill with blood, increasing the difficulty of the operation, which will be still further enhanced if the ligation has been undertaken to secure a severed

¹ Guthrie never practised this mode. Arnott did so, and, to judge from his description, did not escape tribulation. (*Medico-Chirurgical Transactions*, vol. xxix. p. 43.)

² Wounds and Injuries of Arteries, p. 38.

³ Loc. cit.

artery at the site of a wound, as in Arnott's case. Hence, before undertaking any such procedure, it is wise to render the part bloodless by means of the Esmarch bandage. I should myself not dream of operating after this manner; indeed, I consider that the large division of parts, and the interference with intermuscular spaces, render this mode unjustifiable, while a method so much less severe, and at least as easy, lies at hand.

The other method, which I very decidedly recommend as preferable, presents no great difficulties. The popliteal artery divides into its three terminal branches about three inches below the middle of the popliteal space. From this point, half way to the malleolus, the vessel is sought from the inner side, under cover of the inner origin of the soleus; below that point the muscle ceases to arise from the bone, and may be pushed aside. The nerve lies superficial, that is, behind the artery, and, except quite at the top of the region which we are considering, to its outer side.

The operator finds the inner, posterior margin of the tibia, and about half an inch behind that line makes an incision $2\frac{1}{2}$ or 3 inches long; this should expose the fascia which covers the soleus, and fixes it to the bone; it also exposes the internal saphena vein (often separated into several branches), which with a little caution, can be turned aside and spared. After division of the fascia, the origin of the soleus, which, except quite above, is aponeurotic, comes into view. A little gap may be made in this, a director passed beneath, and the muscle severed from the bone. On holding the posterior edge of the incision, including the muscle, backward, while the foot is well extended, the anatomist recognizes the long flexor of the toes lying upon the tibia, and covered in by the deep layer of fascia; the finger must be placed on this muscle, and passed on till the nerve and artery are felt—or seen, if the back flap of the wound be drawn well backward and outward. Now the deep fascia should not be divided immediately over these parts, but a little on the inner side; only a slit big enough to admit the tip of the forefinger need be made, as the rest will tear, and then the finger impinges directly on the artery, and may guide the aneurism needle around it, while at the same time it pushes the nerve outwards. The veins should be included in the ligature; they lie close to the vessel, and cross-branches so encircle it that it is barely possible to separate them, while their occlusion does no harm whatever. This operation will serve for any case of aneurism or wound that lies a little below the inferior edge of the popliteus muscle. An aneurism above that point may rank with popliteal aneurisms, and should be treated in a like manner.

A little more than half-way down the leg, the posterior tibial artery becomes less protected; at the lower part of this region, an incision midway between the tibia and the inner edge of the Achilles tendon, will find it lying to the inner side of the nerve, on the flexor longus digitorum. I need hardly add that the deep layer of fascia must be divided. At the upper part of this lower half, the procedure resembles that already described for the superior half of the leg; but the soleus has ceased to arise from the bone, and is only attached to it by a layer of fascia; this being divided, and the edge of the muscle being recognized and turned aside, the artery may be found, and the needle passed as in the higher operation.

The *popliteal artery* was often tied before the time of Hunter; the operation being no longer employed for aneurism of the popliteal artery, can very rarely, if ever, be required; the only contingency in which I can conceive it to be justifiable, would be in certain cases of hemorrhage from suppuration of an aneurismal sac placed low on the artery (p. 899). The vessel may best be reached from the inner side, by an incision carried just in front of the sar-

torius and semi-membranosus muscles. On division of the fascia, those parts are drawn back with a broad retractor; the strong round edge of the adductor magnus, as it becomes tendinous, is easily recognized, and by cautiously tearing the loose tissue behind that muscle with the finger or with the handle of the scalpel, the artery is easily reached. The nerve does not come into view; the vein is to the outer side, and posterior to the artery.

POPLITEAL ANEURISM.—The treatment of popliteal aneurism must always be, for very many reasons, a matter of great interest to the practical surgeon. It is the most frequent of all aneurisms with which he has to do. It is very variable in its severity, so that the remark which has been applied to all forms of the malady is peculiarly fitting here: "Some aneurisms so tend to cure themselves that very slight artificial assistance suffices to induce their solidification; others obstinately resist one effort after another, and the cure when at last effected may destroy the vitality of parts beyond." It is open to every mode of treatment applicable to the whole range of aneurismal disease, each and every method having been employed successfully and otherwise. Nor is historical interest wanting. It is the first important aneurism in which Anel's method, and the first in which the Hunterian, the flexion, and Reid's method (Esmarch's bandage), were employed.

In making choice of how he shall treat any aneurism at the back of the knee-joint, the surgeon must consider both the local and the general condition of the patient. One would gladly avoid tying a large vessel if milder means will avail, but it is necessary to be sure that the proposed method is

Fig. 543.



Popliteal aneurism growing forward.

milder, or rather that the time which it requires is not so prolonged as to render it both painful and severe. Neither pressure, flexion, nor the use of the Esmarch bandage is painless, and when prolonged, none of them is without its dangers.



Flexion.—Certain aneurisms being more than others amenable to cure by flexion, it is well to have some clear conception of the circumstances which should induce us to make trial of that method. These are both general and local. The former are early age, not over forty-five or fifty at most; a non-irritable, placid temperament; and absence of the gouty or rheumatic diathesis. The favorable local conditions are, distinct sacculation of the aneurism, which should be of quite moderate dimensions and with somewhat distant pulsation, that is, should be padded with some considerable amount of clot; the sac should in preference be situated at the lower part of the popliteal space, or at least not higher than the middle, for aneurisms which originate and lie

on the upper part of the vessel are rarely benefited by this treatment; the sac should also spring from the posterior wall of the artery, and grow backward towards the skin, or at least not forward. When the tumor springs from the front of the vessel and increases towards the bone, it pushes the artery back

so that it does not become sharply bent during flexion of the knee, and the current in it is but little affected, as for instance in the aneurism here shown. (Fig. 543.) In all but large and thin-walled aneurisms the experiment may be made by bending the limb: when pulsation is but little or not at all affected by the amount of flexion which the patient can voluntarily produce, or when bending to an angle of sixty degrees does not annul the aneurismal pulse, the method is likely to be ineffectual.

Flexion must also be contemplated in other aspects, as an adjuvant to other treatment: as perfecting a cure which pressure has commenced, and as an appropriate remedy for recurrent pulsation after ligature.

The majority of cases in which flexion has been used have not been treated by it alone and unaided. Sometimes when indirect pressure has become unbearable, an interval has been granted to the patient, during which, lest the advantage already gained should be lost, the knee has been kept bent; and occasionally during this time the aneurism has become solid, and this has occasionally happened even though, before using pressure, flexion had failed. In some cases this posture has cured an aneurism which did not appear to be, though it probably was, benefited by long-continued, indirect pressure; or again, pressure previously ineffective has after a certain period of flexion cured the disease. Some surgeons have used occasionally with success flexion and pressure simultaneously.¹

The simplest method of applying flexion is to leave the limb bare, and by means of a slipper, to the heel of which a cord is sewn, to attach the foot to a girdle round the thigh or pelvis. But the method is likely to prove more efficacious if the limb be bent at the hip as well as at the knee, and a proper bandage prevents swelling and sometimes diminishes pain. The limb, exclusive of the aneurism, should be enveloped in a thin flannel or domett bandage; the leg is bent on the thigh, and the thigh on the abdomen; occasionally a pad may be placed in the popliteal space, if it aid in producing pulselessness not otherwise attainable; but the appliance must be cautiously used; it obstructs veins also, and has been productive of gangrene. The methods whereby the limb may be fastened in this position are very various. A mere bandage round the ankle and thigh, though simple, is apt to injure by pressure, or to become unbearable. Some surgeons fasten the ankle near the buttock by means of a belt around the pelvis, and then bandage the thigh to the loins and back. I have found it conduce to the patient's comfort to buckle around the waist and upper part of the pelvis a broad belt, provided with a Y-shaped portion inverted, thus ; the stem of this part is secured to the belt over the anterior superior spine of the ilium. The branches lie one on each side of the thigh. A similar strap hangs behind from just outside the sacro-iliac joint. Each branch bears a buckle. The shin is placed in a leather gutter, like those provided by instrument-makers as slings for the forearm; it is well padded, and provided with straps near the front and back end. When these appliances are adjusted, each to its own place, the ends of the  in front are fastened to the foremost straps of the tibial sling, and those behind to the hindmost ones, by regulation of the length of each strap; the limb may be restrained in any desirable posture. In New York and Philadelphia, the limb is secured by a belt running obliquely over the shoulder.

In whatever way it be done, the patient will certainly be more comfortable if part of the attachment be elastic, so as to do away with the distressing sense of rigidity, so often complained of.

Patients should be encouraged to lie on the diseased side, the limb comfortably supported by pillows; an occasional change of posture on the back, or

¹ Flexion for recurrent pulsation need not be further mentioned here, see p. 900.

even to the sound side, may be allowed, the limb under treatment being thrown across the other. An advantage, however, is gained by the first of these positions, viz., the possibility of combining with flexion pressure by a weight, after the manner shortly to be described.

This mode of treatment is by no means painless. As already stated, different persons bear it with very varying degrees of tolerance, but no one bears it well when it is rigorously practised. It is more prudent to commence with a slighter degree, even though it may not annul pulsation; after a little while, the further degrees will be more readily borne. Occasionally one of the methods, which to some persons may have been tolerable, will be to another unbearable; yet he may be tolerant of some other mode of fastening the limb. Continuance of one posture is not essential; indeed, some cases have progressed more rapidly and much more comfortably by allowing intervals of rest. In a few instances, when pulsation though much diminished continues, relaxation of treatment has been followed by cure.

In its results, flexion is very capricious. Occasionally the aneurism has so great a tendency to spontaneous cure, that simply lying in bed with the knee spontaneously bent has, in a few hours, produced solidification. On the other hand, many attempts have been abandoned as useless, after weeks of severe and painful treatment. It appears desirable to give the results of treatment as far as my opportunities have allowed me to collect them. In doing this I avail myself of two sources—published cases and hospital records. In using the former, we must accept the numbers with very great caution. Successful cases are almost all published; want of success is rarely made public.

I gather altogether, since the first introduction of the method by Maunoir, 91 cases; of these, 42 have been successful, 49 unsuccessful.¹ Of the unsuccessful cases, 25 came to ligature; 13 were cured by pressure; 4 were amputated; 3 terminated fatally; the ultimate destiny of 4 is unknown.

The causes of amputation and of death were gangrene, suppuration, and rupture of the sac. It must, however, in justice, be noted that flexion was employed alone and by itself in only 26 of the 91 cases, and that of these 19 ended in recovery; this large proportion of cures set down to the method when used alone, indicates merely that a certain number of aneurisms are easily curable; flexion happened to be the method employed; the more recalcitrant cases became subject to successive forms of treatment.

If we pass to hospital reports, more reliable because every case and not merely selected instances are recorded, we find in those six hospitals² which I have taken, 7 treated by flexion alone, and 9 by flexion aided chiefly by some form of pressure. Of the 16 cases, 7 were successful, 6 unsuccessful, 2 came to amputation, 1 ended in death.

Esmarch Bandage. (*Reid's Method.*)—The Esmarch bandage has been extensively used in popliteal aneurism; its application and its mode of action have already been described (p. 875). I have also taken occasion to remark that its success, when that occurs, is so rapid that it offers a great charm, both to patient and surgeon. The ease with which it can be applied, even by very inexperienced hands, is an additional reason why this method will often be used. It is, however, not without its dangers—the chief and more immediate being gangrene, the less frequent and more remote, thrombosis and inflammation of the sac.

¹ There is no doubt that very many more have been unsuccessful. Often reports of cases state that previous to ligature "other means," or, "pressure and other means," were employed; or some similar phrase is used. I have counted no cases here unless flexion is specifically mentioned. In my collection of cases, Dr. Fischer's table (*Prager Vierteljahrschrift*, Bd. civ. S. 161) has been used for cases previous to 1869; the rest are due to my own research.

² The six hospitals are St. Bartholomew's, Charing Cross, St. George's, Guy's, St. Thomas's, University College.

So much has been said concerning its mode of application and after-management, that nothing need here be added save a statement of results. In the surgical section of the International Congress held in London, 1881, Mr. Gould gave certain numbers, which, being so recent, may be accepted as correct up to the time of writing. I find that, for popliteal aneurism, Reid's method is recorded to have been employed 47 times, and to have been successful 27 times. The 20 cases of non-success include 1 death directly attributable to over-zealous repetition of the treatment, causing collapse. One case was cured by proximal pressure; eighteen patients were subjected to ligature, of whom 3 died, 1 submitted to amputation, and 1 had gangrene of the foot.¹ Of the 47 patients, 22 were subjected to the treatment more than once; of these, 1 died and 13 remained uncured.

Indirect Pressure for Popliteal Aneurism.—This may be either digital, or may be effected by means of a weight, or by instruments. To carry out the first method (*digital pressure*), a number of more or less trained assistants are necessary,² viz., from eight to twelve. They should be instructed to remain, two or three at a time, with the patient, each section to be on duty four hours. No. 1 should keep his hand on the tumor, while No. 2 compresses the artery against the body of the os pubis; it is the duty of the first to warn the compressor of any return of pulsation in the sac. When the assistant restraining the artery is tired, the third man present should relieve him, not by taking his place at the groin, but by pressing on the vessel at the apex of Scarpa's triangle. No. 2 now relaxes his pressure, being in readiness to reapply it if No. 1 gives notice that the lower pressure does not duly control the vessel. At the second change, No. 1, hitherto untired, as he simply has kept a touch on the sac, takes his turn as a compressor. In order to spare muscular fatigue, and thereby prolong the time during which each assistant can hold the vessel, a weight should be provided—either a mould of lead or a bag of shot, weighing from four to six pounds—which is placed on the back of the compressor's fingers.

Weight pressure is carried out in much the same way, but without the fingers; an assistant, or trained nurse, should be present, to occasionally feel for pulsation in the tumor, and, if necessary, to readjust the weight. This weight may be of various forms: some surgeons use simply a bag of shot, weighing from 4 or 6, up to 12 lbs.; others employ one piece of lead, so cast as to fit the groin, and another to fit the front and inner aspect of the thigh. Mr. Tufnell is fond of two weights; the one, an oval, has a long diameter of $5\frac{3}{4}$, a short one of $4\frac{1}{4}$ inches. The surface which is next the skin is convex, with a subsidiary protrusion, a sort of nipple; indeed this aspect resembles in form the female mamma; the other surface is flat; the thickness from the centre of the oval surface to the point of the boss is $1\frac{3}{8}$ inches, the weight is 2 lbs. This is laid on the part, so that the projection accurately corresponds to the artery, and upon the flat surface an ordinary weight of from 8 to 12 lbs. is placed. In the use of all weights it is convenient and of great assistance to have them suspended above the bed by a crane-like arrangement; this prevents their falling off when the patient moves, and, if a pulley be supplied, facilitates modifications in the amount of pressure. Either the shot-bag, or the moulded, or Tufnell's subsidiary weight, can thus very easily be slung up. Other forms have, in certain special cases, been used; individual difficulties may be met by commensurate resources.

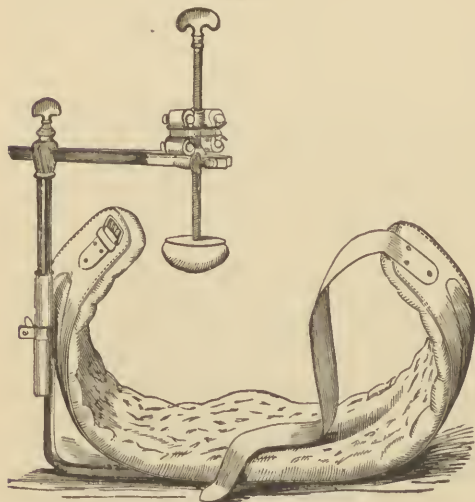
¹ Which coming on four days after deligation, was probably attributable, at least in part, to the previous use of the Esmarch bandage.

² In a few rare cases, nature requires so little aid that the patient can himself make all the pressure required; in others, two or three persons are enough; but the rules of surgery cannot be founded on exceptions.

Instrumental pressure is capable of almost infinite variety; certain patients bear one form of appliance, which other patients cannot tolerate. I will only mention here those forms which have most generally proved useful. Skey's tourniquet (Fig. 108, Vol. I. page 513) has in a certain number of cases fulfilled its purpose well; it is not adapted for making pressure at the groin; but for parts lower down it is valuable, the ease with which it can be shifted from one part to another being of great advantage, though the pad to receive the back of the thigh is not sufficiently large. Nevertheless, it is often very bearable, and may be used with Carte's compressor, or simply with a weight for the groin. An instrument which enjoys considerable reputation is Signoroni's tourniquet (Fig. 107, Vol. I. page 512); it is in form like a horse-shoe, at whose ends a screw and ratchet arrangement is introduced, and at whose ends the pads for pressure and counter-pressure are placed. A modification of this instrument has been introduced by placing at the pressure end a cross-bar carrying at each extremity a pad; this enables the surgeon to alternate the point of pressure from one place to another. This instrument cannot be used at the groin; the pressure exercised by either of these mechanisms is rigid and unyielding, and hence it is to many patients insupportable. I confess to a strong preference for a larger instrument, such as Carte's, although its complication is certainly no recommendation; but the comfort of the appliance, the method in which it holds the patient, so that the compressor is not likely by accident to become displaced, the ease with which the pressure can be applied and afterwards alternated, and the arrangement of the screw, so that the introduction of strong India-rubber rings enables the pad to spring with each pulsation of the vessel, are great advantages.

The apparatus consists of two separate portions; the one for the groin, the other for the thigh. The former is a saddle made to fit the back and sides of the pelvis, being comfortably padded to their form. On one side is a rod with a socket, carrying a vertical, and that a horizontal, sliding arm, each

Fig. 544.



Carte's compressor.—Groin portion.

Fig. 545.



Carte's compressor.—Thigh portion.

provided with a binding screw. At the end of the horizontal arm is the compressing rod and screw, the rod running through a ball-joint and double socket connected together by broad flat India-rubber rings, giving a certain play and resilience to the screw. The socket in which the upright arm turns, and that

in which the horizontal works, give means of moving the pad into any place; the ball and socket joint at the end of the horizontal arm enables the tourniquet screw to take any direction. By this means the femoral artery can be compressed fairly against the body of the pubis in such a direction as shall give the most effect to the least mechanical effort, and, therefore, with the least pressure on the skin.

The other part of the instrument is a stirrup-shaped tourniquet, with hinge and clamp at the sides. The arrangement of the tourniquet screw is the same as in the upper or groin portion. The two are intended to be used alternately.

Esmarch has devised a mechanism in which the compressor is a staff or rod of wood, shod with lead, and suspended by an upright and cross piece above the patient's bed, in such wise that a greater or less weight may fall on the vessel, or that the patient grasping the staff may aid its pressure by his own manual force. Esmarch describes this as very efficacious, and of facile use, and gives it the name of "Stangendrück."¹

In a previous part of this article, the principles which are to guide the surgeon in the use of pressure have already been discussed. I need only repeat here that either the rapid method, with or without anæsthesia, or the gradual method may be chosen; in the former, the artery must be so controlled that no beat of the tumor takes place, while the latter may be more gently regulated. Some surgeons prefer entirely to annul pulsation, and this probably is more certain of producing consolidation, though it is more dangerous, as being likely to lead to ulceration or sloughing of the skin, besides certain other untoward events, such as gangrene, sloughing, or rupture of the sac; while a slight wave of blood through the tumor is by others thought to be advantageous. As a rule, the cases which are subjected to the gradual method occupy the longer time in cure, while those treated by complete occlusion are more liable to relapse.

The *statistics of compression* in its various forms might be made very complicated, if we took separately cases in which any one form was used alone, and likewise the almost endless combinations that were produced by commingling methods—some commencing in one way, some in another; but I think that no good purpose would be answered by such a course. I have found that in taking any one mode, and gathering from publications its results, we get an altogether erroneous proportion of successes, because failure induces the surgeon to try something else. Hence, all the more obstinate aneurisms are treated in a number of ways; those that tend to cure themselves, or that require but little artificial aid, in one way only.²

I have collected from American, British, and Continental journals, all the cases I have found, from 1870 to 1879 inclusive. I find that 148 cases of popliteal aneurism have been treated by the various forms of pressure. Of these, 68 were successful, while 80 ended in failure.³ Of the unsuccessful cases, 57 came to ligature; 9 patients went away declining further treatment, or were dismissed with a still pulsating tumor; 4 suffered amputation; 6 died. The deaths were thus distributed: 1, cause not given; 2, rupture of sac (one of them into the knee-joint); 1, gangrene; 2, thrombosis. The causes of amputation were: 2, rupture of sac; 2, gangrene. Of these cases, 2 died from secondary hemorrhage; 1 from spread of gangrene; 1 survived.

¹ Verhandlungen der Deutschen Gesellschaft der Chirurgie, 4. Congress.

² Dr. George Fischer, of Hanover, has given in the Prague Vierteljahrschrift, 1869, S. 167, tables of cases treated by digital compression, gathered from a vast number of journals. The number of popliteal cases is 89; of which 57 were cures and 32 failures.

³ If from published reports we cull those that are headed as treated by indirect pressure, we get very different proportions. It is among those that are stated to have been subjected to deligation, that the greater number of failures of pressure treatment have occurred.

Reduced to decimals, we find of cures	.	.	.	45.94 per cent.
“ “ “ of failures	.	.	.	54.06 “
Dying with or without amputation	.	.	.	6.08 “
Surviving after amputation	.	.	.	0.69 “

Few cases are treated entirely by one method. In the intervals of instrumental pressure, either a weight or slight finger pressure is used, or *vice versa*; flexion to a moderate extent may be superadded to either method. I have taken in the 68 successful cases a certain standard for dividing the examples into a more or less conventional series of categories, only placing among the “combined” those in which two or more forms were used about equally, so that one could not be regarded as a mere adjuvant to the other. The longest time of persistence ending in cure was 6 months (digital and instrumental pressure combined). We find among the protracted periods, 6 months, 3 months, 54 days, 7 weeks, 38 days, 4 weeks, 1 month, 3 weeks, 21 days, and so on.¹ The methods employed were respectively the combined, combined, instrumental, digital, weight, staff-pressure, combined, combined, and digital. The shortest period was 4½ hours.

Of the cures	.	.	.	.	26	were due to instrumental pressure.
“ “	.	.	.	.	21	“ “ digital “
“ “	.	.	.	.	12	“ “ combined “
“ “	.	.	.	.	6	“ “ weight “
“ “	.	.	.	.	3	“ “ staff “

For *instrumental pressure* the longest period was . . . 7 weeks.
 “ “ “ the shortest “ . . . 24 hours.

Average of the 19 cases in which time of cure is stated . . . 12 days.

For *digital pressure*, longest period . . . 21 days.
 “ “ “ shortest period . . . 4½ hours.

Average period of the 13 cases in which the time is stated . . . 5½ days.

For *combined pressure*, longest period . . . 6 months.
 “ “ “ shortest period . . . 44 hours.

Average period for the 12 cases in which the time is stated, 44 days 8 hours.²

We now will take the results as shown in the reports of the six hospitals before named; they are a little more favorable. I find exactly 90 patients treated by pressure in the ten years. Of these, 44 were cured, in 38 the treatment failed, 4 submitted to amputation, and 4 died. Of the unsuccessful cases, 34 came to ligature; the causes of amputation were in 2 gangrene, in 1 rupture of the sac, 1 not stated; 2 of these patients survived. The causes of death were gangrene in 2, exhaustion without gangrene in 1, thrombosis in 1.³

Deligation of the Superficial Femoral Artery for Popliteal Aneurism.—This operation is rarely practised in Hunter’s canal, although in certain contingen-

¹ I give the periods in the words of the authors.

² Among the instrumental cases, a few of long treatment run up the average thus high: two, for instance, of 7 and of 5 weeks, respectively. To the combined method, all the most obstinate cases fall. Thus we have 7 very long cases, namely, 6 months, 3 months, 13 weeks, 54 days, 5 weeks, 30 days, 1 month. As already mentioned, this arises from reiterated and varied attempts to cure obstinate aneurisms.

³ I cannot be sure of the absolute correctness of these numbers; in some of the hospitals, the reports were, for a year or two of the included time, not very well kept; by questioning and abundant reference I have been able to get particulars in some cases; when I have not been able to do so, I have omitted the cases altogether. I should like to take this opportunity of thanking the present registrars of the various hospitals for their most kind and courteous aid, without which it would have been impossible for me to complete the tables whereof the above is a summary; they are arranged for each hospital in the order given. I do not think that I can give the times of treatment with sufficient accuracy to render the calculations reliable, nor shall I follow this plan for other aneurisms save the femoral. Concerning pressure used in the upper extremity, a very few words must suffice.

cies the surgeon may now and then be called upon to tie the vessel in that situation. As a very general rule, the artery is bared just as the sartorius muscle crosses it, and before it gets into the tendinous channel. The guides which I myself follow are two. I bend the patient's knee, abduct the thigh a little, and rotate it outwards just enough to let it lie comfortably upon its outer side, then draw an imaginary line from the centre of the femoro-abdominal fold to the innermost projection of the internal femoral condyle, and another from the anterior iliac spine to the junction of the middle and lower thirds of the thigh. Where these two lines meet, the operator will find the sartorius covering the femoral artery, at a distance averaging in the full-grown man about one and a half inches below the offset of the profunda. Fixing this point in his mind, the operator makes an incision about two and a half inches long, longitudinally down the limb, in such wise that the imaginary point shall be at its middle, or a little below its middle; having cut through the superficial fascia and the fat, often abundant at this place, especially in women, the fascia lata comes into view, and generally one may see through it the outlines of the muscles. That of the sartorius, enveloped by itself in a sheath or fold of the fascia, must be visible before the operator goes further. If, therefore, he does not recognize this, he should move the outer wound from side to side until he finds the muscle's inner edge and knows his exact situation. By passing the knife along the inner margin of the sartorius, and turning the muscle over or drawing it outward, the sheath of the vessel is exposed, generally with the long saphenous nerve running along its outer aspect; this is to be detached and held aside, the sheath of the vessel cautiously opened, and the aneurism needle passed beneath. I do not consider that it matters much which way one passes it, since the vein here lies almost directly behind the artery; the non-inclusion of the vein should, however, be verified. It has once happened to me, and I have seen it occur in the practice of two other surgeons, that in isolating the artery a gush of venous blood has occurred; we all three feared that we might have wounded the vein, and lost a good deal of time in the use of pressure and in looking for an orifice. In all three cases, when pressure was avoided and the artery tied, bleeding entirely ceased.

The operation for tying the artery in Hunter's canal is performed at a rather lower point; the incision is a little more to the inner side, and must be longer. The line from the centre of the groin to the inner condyle is here the guide, but if the saphenous vein be visible through the skin, the knife may be kept in front of it; if invisible, a little caution in the first use of the scalpel will avoid it, and being looked for in the fat, it may be turned aside. The fascia lata, now exposed, lets the sartorius be seen through it; the outer border of the muscle is in this operation to be sought, the fascia divided, and the muscle pushed inward. The structure now revealed is the piece of thin but strong fascia that roofs in, as it were, Hunter's canal, stretching in this place from the vastus internus to the tendon of the adductor longus; this fascia is easily divided; the artery, with the vein a little more on the inner side than it was higher up, and the saphenous nerve close to it on the outer side, is now exposed; both vein and nerve must be avoided by the needle, which may be best passed from without.

The superficial femoral may be tied for aneurism of the femoral artery low down, as in the canal of Hunter, but is more frequently tied for popliteal aneurism. This is of all deligations the most frequently performed, and its statistics stand thus: First, we will take gatherings of published cases; and here I may avail myself of an excellent compilation by Dr. Rabe,¹ who has collected

¹ Zur Unterbindung der grossen Gefässstämme, etc., Zeitschr. für Chirurgie, Bd. v. S. 140.

altogether 259 examples of deligation of the superficial femoral artery, from the time of Hunter's first case to 1873. For reasons which will soon appear, I make use of his table only up to the end of 1869. This gives us 230 cases, of which 187 were cured, while 43 were fatal. To these figures I am able to add for the additional ten years, 1870 to 1879 inclusive, 67 cases with 10 deaths, making altogether 297 cases with 53 deaths—a mortality percentage of 17.8 in the whole period since Hunter first introduced his operation.

Up to 1870, the percentage of deaths was 18.7; since that date, it has been 15.6; but we may go further. A large number of the deaths occurred in the first half of the decade from 1870 to 1880, viz., in 32 cases 7 deaths and 2 amputations (the patients surviving)—a death-rate of 21.87; or if we include the amputations under the head of failures, we have the terrible percentage of 28.1. From 1875 to 1879 inclusive, the mortality declines immensely; we have, namely, 35 deligations with 3 deaths and no amputations—a mortality of 8.57 per cent. I have excluded cases of temporary ligature. I fear we must conclude that numbers obtainable by collecting published cases furnish unreliable and far too favorable results. If we turn to the records of the six London hospitals above quoted, we find a very different death-rate. The number of deligations for popliteal aneurism amounts to 52; of these only 40 were cured while 12 died—making a death-rate of 23.08—a percentage which is certainly higher than it ought to be,¹ and, I firmly believe, very much higher than in a short time hence it will be, that is to say, when the best form of ligature shall have been determined upon and adopted.

This question of the form of ligature is of immense importance; the matter has been already in part discussed, but a few numbers and considerations may here be given. Of the 52 hospital cases above quoted, we must subtract 7 in which the sort of ligature is not specified; the other 45 may thus be tabulated according to the sort of ligature:—

Substance used.	No. of cases.	No. of deaths.	No. of relapses.	Percentage of failures.
Silk	14	3	1	21.4
Catgut	27	6	3	26.
Ox aorta	4	0	0	0.

Under the head silk, the relapsed patient died; under that of catgut, two of the relapses ended fatally; thus the numbers overlap. There were in the cases tied with silk 3, in those tied with catgut 7 failures.

Causes { Silk, 1 rupture of aneurism at site of ligature; 1 secondary hemorrhage; 1 pyæmia.
of { Catgut, 1 exhaustion and bedsores;² 1 erysipelas; 2 secondary hemorrhage; 2 after re-
death. { tying for relapse or fresh aneurism at site of ligature.

If now we consider the ten failures, we find that six, besides one case of relapse in which the patient afterwards got well, were due to the action of the ligature on the coats of the vessel. There would have been no formation of aneurism at the site of ligature, and no secondary hemorrhage, unless the arterial tunics had been damaged. Relapse would have been only an occasional cause of failure if the catgut ligatures had not become too rapidly soft.

¹ It must be remembered that we are dealing with such small numbers that any infelicity of management affects unduly the whole calculation. Thus in one institution whose number of deligations happens to be large, we find that in more than one-fourth of the cases, relapse with ulceration of the vessel occurred, or a new aneurism formed at the site of the ligature. All but one of the patients died, either with or without retying. As such cases are not noted in any other institution, it seems a necessary conclusion that in this one a fashion prevails of pulling the ligature too tight.

² The fatal issue in this case was due more to previous prolonged pressure than to ligature.

FEMORO-POPLITEAL, FEMORAL, AND INGUINAL ANEURISMS.—We now leave popliteal aneurism, and, following the course of the vessel upward, we find that that portion of it which traverses the opening in the adductor magnus is also liable to disease; being situated partly in the thigh and partly in the popliteal space, it is called *femoro-popliteal* aneurism in this locality, and its surgery and statistics are included in those of popliteal aneurism. Above this lies what is termed *femoral aneurism*, under which name is understood merely aneurism of the *superficial* or of the *common* femoral artery. The former of these may occur either in Hunter's canal or in the lower part of Scarpa's triangle; the latter is named after the artery it affects, or, especially if high, is also termed *inguinal*. Aneurism of the *profunda* is called by that name; it is femoral in situation, but requires a distinctive designation; it is a rare malady, and is not usually easily diagnosed from some of the forms above mentioned. A femoral aneurism seated in Hunter's canal may be treated by one of the varieties of pressure, or by flexion at the hip and knee, as well as by ligature of the superficial femoral artery.

Pressure may be carried out, if the aneurism be low on the thigh, exactly as has been directed for popliteal aneurism; if higher, only the groin is available for compressing the vessel in the limb; but by a horse-shoe, an abdominal, or a Signoroni's tourniquet, or by a weight, the external iliac artery may be controlled. This treatment is not as efficacious as in popliteal aneurism. I find that since 1869 it has been, according to published accounts, employed 38 times;¹ 10 of the cases were successful, 25 came to ligature, 1 to amputation, and 2 died. Of the 10 successful cases, 7 were treated by complete compression, in 5 with the aid of an anæsthetic. The longest period of treatment in successful cases was 3 days, the next 27½ hours, the pressure of course being at times interrupted. The shortest period was 1½ hours (digital pressure); the average duration of treatment till the aneurism was consolidated was 4 days. The amputation was for gangrene, after 8 days' pressure. Two deaths occurred, both from pulmonary thrombosis and pneumonia—one after 19 hours' compression, and one after treatment lasting 19 days, with intermissions of 6 and 9 days. In one of the successful cases peritonitis had nearly destroyed the patient, and another was cured only just in time, a deep slough having formed which on separation exposed the artery.

In one of the 25 cases that came to ligature, the common femoral was tied, and in one the superficial femoral; catgut was used in both, and both did well. In the others, the external iliac was tied. Of these operations we shall speak immediately.

Turn we now to hospital experience. In the ten years and six institutions already given, I find that 32 cases are recorded, but of two it is merely mentioned that they were in hospital, and one was a doubtful case, which it was proposed to treat by rest; the man thought that he could lie in bed at home, and went away.

I have then to deal with	29 cases.
Of these were cured	6
Deaths	4

The causes of death were:

Rupture of sac	2
Thrombosis of femoral vein	1
Thrombosis with pneumonia	1

¹ Under this category falls the case of femoral aneurism which by pressure was cured in six years, and which, as it was entirely exceptional, I here exclude from my computation of time.

The longest time of interrupted pressure was	.	.	.	4 months.
The shortest " " "	.	.	.	6½ days.
The longest time of continuous complete pressure ¹	.	.	.	44 hours.
The shortest " " " "	.	.	.	4½ "

The *Esmarch bandage* may also be made available for femoral aneurisms, especially for those at the lower part of the thigh. In this situation, the mode of application is exactly similar to that for popliteal aneurism. But for high femoral and for inguinal aneurism a different method has been employed—a method, indeed, which is more like rapid indirect pressure than like Reid's method of cure. The flat bandage being applied, the large horse-shoe tourniquet is screwed down on the aorta, or on the common iliac, or on both alternately. The bandage is removed when its pressure becomes too painful; but the tourniquet is retained as long as possible, and then exchanged for digital pressure, when that is available. It is doubtful whether the distal application of the bandage has any effect on the aneurism.² The recorded cases treated in this way, femoral and inguinal, are 9; of these 5 were cured, 2 proved fatal (from rupture of other aneurisms), and 2 were afterwards cured by ligature of the artery.

Two of these cases were of inguinal aneurism; one patient died, while the other recovered after one hour's treatment, the case being evidently one of that kind already more than once referred to, which has a tendency to spontaneous cure, and which requires very little artificial aid to enable nature to complete that process.

We will now go on to deligations.

Ligation of Common Femoral.—The operation of tying the common femoral artery is not often performed; indeed, it has been by some surgeons entirely condemned, the neighborhood of large branches preventing what has been considered essential for success, the formation of a sufficient coagulum. This point, and the change of treatment justified by the use of soluble ligatures, have already been considered (p. 902).

Two modes of operation are described: the one by a transverse or nearly transverse incision, parallel to and a little below Poupart's ligament; the other by a longitudinal incision over the course of the artery, that is, from the middle of the femoro-abdominal fold downward. I prefer the latter method, since, the superficial branches (epigastric, pudic, and circumflex ilii) being spared, less blood is effused, and the further steps are facilitated. The first incision should expose the fascia lata; this may be divided just outside the line of pulsation, so that, the inner margin being pressed inwards, the sheath is exposed; this is next lifted by forceps, punctured, and then incised on a director, the vessel being thus laid bare in its own particular division of the sheath. The aneurism needle should be passed from within outwards. Unless a high giving off of the profunda can be detected with the finger, it is better not to tie the vessel immediately under Poupart's ligament, but rather lower down.

Deligation of the external iliac artery low down is an operation of no great difficulty, and should not occasion much bleeding. It is usually performed by a slightly curved incision above the inguinal canal, which must not be opened. I think that the usual mode, namely, by an incision almost parallel to Poupart's ligament, though it facilitates finding the artery, exposes the

¹ In this case and in another (32 hours), deep and dangerous sloughing took place.

² The two cases thus treated belong to Mr. F. A. Heath (Brit. Med. Journal, 1877, vol. i. p. 495), and to Mr. Stables (Lancet, 1879, vol. ii. p. 791). In the one, instrumental and digital pressure was kept up remittently for 36 hours, when the man died. In the other, the flat bandage was used for 30 minutes, and instrumental pressure for 1 hour.

patient almost certainly to the subsequent inconvenience of a large hernia which can hardly be kept back. This danger is minimized by making the incision rather less horizontal. I proceed thus: having found the external abdominal ring, which, in a thin subject, can easily be felt—in a fat man, if its position cannot be so certainly ascertained, the scrotum may be invaginated, and the finger passed into the canal—an incision is begun at a point about an inch outside its outer column, and half an inch above it, and carried an inch on the inner side of the superior iliac spine. This incision should have a slight incurvation, with convexity looking downward and outward. The aponeurosis of the external oblique must be distinctly seen, and incised. Then the internal oblique, and afterwards the transversalis muscle, must be recognized and divided. It is important really to see these parts as separate entities, and the operation is best done by dividing each to nearly the whole extent of the first incision, and in the same curvilinear direction. The operator is greatly helped by a certain tenseness of the abdominal walls; if this be not normally present, an assistant should produce it by pressing gently with his flat hand at and below the umbilicus.

The next step of the operation must be carefully carried out, viz., division of the fascia transversalis upon the peritoneum. The safest plan is to pinch up a little fold with the forceps, incise it with a blade held flatwise, and gently insinuate an oiled director to a little beyond the required distance; before slitting it, the director should be withdrawn about one-quarter of an inch, so as to release a little pucker of the peritoneum, which often laps over the end of the instrument. Now the surgeon, with all four fingers of his hand laid gently upon it, presses the peritoneum, with the bowels, gently over towards the middle line, detaching it from the iliac fossa until he reaches the brim of the pelvis. Here he will find the artery lying just inside the psoas muscle, with the vein on its inner side. The vessel is in a fascial covering, which must be opened so that the artery is really bare; but the operator must spare the genito-crural nerve, which lies generally upon the vessel, a little towards its outer edge.

It should be noted that previous pressure, especially if long continued, renders this operation difficult and hazardous. More than once it has been noticed that by this means the fascia transversalis has become so adherent to, so incorporated with the peritoneum, that it has been impossible to separate them, and that the latter membrane has been necessarily incised. Such wounds are not at the present day necessarily fatal, but they add very much to the patient's danger, and very considerably to the surgeon's difficulty if protrusion of the bowels occurs. Indeed, I have before me the records of three cases in which the intestines had to be held back by an assistant, while the surgeon sought the vessel through the back part of the parietal peritoneum. One of these cases ended in recovery.

The *statistics* of deligation of the common femoral artery are by no means favorable. Dr. Fischer has, in his tables,¹ collected twenty-five operations performed for femoral, five for popliteal aneurism:—

Of 25 deligations for femoral aneurism	7 did well.
Of 5 operations undertaken for popliteal aneurism	1 “
Of 30 deligations of the common femoral artery	8 “
Recovered after limited gangrene over the sac	1.
From œdema of lung	1 died.
“ gangrene	2 “
“ septicæmia	1 “
Hæmorrhage occurred in	17.

¹ Loc. cit., p. 194.

Of 17 cases of secondary hemorrhage—

Without further deligation	7 died.
After ligature of bleeding ends in wound	1 “
After ligature of external iliac	3 “
After ligature of common iliac	1 “
Without further deligation	2 recovered.
After ligature of external iliac	3 “

I can only find since 1872, at which date Dr. Fischer concludes his tables, one case in which the common femoral artery was tied. This occurred in 1879. The ligature used was silk, secondary hemorrhage came on, the external iliac was tied, and the patient survived. Thus out of 31 cases, bleeding occurred in 18, of which 12 died. To place the matter in percentages, the secondary hemorrhages are 58 per cent., and the deaths on the whole series 51.6 per cent.

The hospital experience in this operation is small—indeed, it is repudiated by almost all metropolitan surgeons—so that I find but two cases in the last ten years; both patients died of secondary hemorrhage, one after fresh deligation, the other with pyæmia.¹

The more usual operation for aneurism of the thigh too high for treatment by occlusion of the superficial femoral, is deligation of the external iliac artery. Dr. Rabe's table gives of such operations 111, of which 26, a little over 23 per cent., proved fatal. My own collection taken from where Rabe leaves off, gives 30 cases, whereof 5 were followed by death, viz., 16.6 per cent., or, taking the whole range since the first operation to 1880, 141 published cases with 31 deaths, an average of very nearly 22 per cent. But these gross numbers require further examination.

Of the 141 cases, hemorrhage occurred in 24; of these 9 recovered, 15 died. Gangrene was observed in 11 (in one of very slight extent); of these 6 died, 5 recovered. Peritonitis occurred in 4, of which 1 died. If we put together the causes of the 31 deaths, we find—

Of hemorrhage	15
Of gangrene	6
Of peritonitis	2
Of erysipelas	1
Of septicæmia	1
Of exhaustion	1
Of retroperitoneal suppuration	2
Of shock and unknown causes	3

The last five headings may be left without further comment. The first three are more important for consideration; I shall not confine my remarks to the fatal cases, for it is desirable also to learn the frequency of unfortunate complications.

Five patients were attacked with peritonitis, of whom only 2 died. It is especially worthy of remark that although the peritoneum was confessedly wounded in seven cases, inflammation ensued in only one instance, and in that the patient recovered.²

Gangrene occurred 9 times; 6 of the patients thus affected died—one after amputation—and 3 recovered, namely, 1 in whom the sphacelus had been very limited, and 2 after amputation.

¹ The operation may have been performed more frequently than is said in the text, but it is impossible to found assertions on such phrases as “in a case of femoral aneurism the *femoral artery* was tied.” If in the report of a certain large hospital we should accept the italicized words as meaning the common femoral, the number of cases would be six instead of two.”

² In one case the small intestines and peritoneum protruded, and had to be returned and kept back during the rest of the operation; no peritonitis followed.

In 16 cases, suppuration, gangrene, or rupture of the sac occurred, 7 times with, and 9 times without hemorrhage. Of the 7 patients who bled, 4 died, one after amputation. Of the 9 who had some such giving way of the sac without hemorrhage, only one died, after suffering amputation.¹ Hemorrhage occurred in 21 cases, proving fatal 15 times. In regard to the place whence the bleeding came, we may divide the 21 cases thus:—

Source of hemorrhage.	No. of cases.	No. of deaths.
Not specified	3	3
From aneurism	7	5
From above ligature, or above and below	9	7 ²
From below ligature	2	0

In two cases in the table marked as “not specified,” the common iliac was tied; both were fatal. In one case of bleeding from below the ligature, the common femoral was tied with good result. In one case of bleeding from the sac, compression below proved effectual; in one, deligation higher up was useless. In the whole number of cases there were two relapses.

Ten years of experience in the six hospitals already named gave 15 cases of tying the external iliac artery (in reality 18 cases, but 3 are so recorded as to be valueless); of these 6, that is to say, 40 per cent., died. The causes of death were—

Pyæmia	2
Peritonitis	3 (in one the membrane wounded).
Secondary hemorrhage	1

In order to have a larger view concerning the form of ligature, I have put together the cases in hospital reports, and those in published records, in which the substance used is specified; of these I find 43 cases thus distributed:—

Substance used.	No. of cases.	No. of deaths.	No. of relapses.	Per cent. of failures.
Silk	9	2	0	22.2
Hemp	5	1	0	20.
Wire	2	1	0	50.
Catgut	25	5	3	32.
Ox aorta ³	2	0	0	0.

Causes of death.	{	Silk, 1 pyæmia; 1 secondary hemorrhage.
		Wire, 1 “
		Catgut, 1 peritonitis; 2 gangrene and rupture of sac; 2 secondary hemorrhage.
		Hemp, 1 wide-spread peritoneal abscess.

GLUTEAL AND SCIATIC ANEURISMS.—I class these two forms of aneurism together, because during life it is very generally, and after death it is occasionally, impossible to determine from which of the two vessels⁴ that emerge at the great ischiatic notch, the aneurism springs. These affections are rare, but not so extremely infrequent as was a few years ago imagined. Thus some years since, Dr. Fischer, of Hanover,⁵ collected thirty-five cases, one of

¹ This does not mean that amputation is not to be practised: it gave the fatally affected patient a slight further chance of life.

² 1 of pyæmia.

³ Of course, in regard to many of the substances, notably wire and ox aorta, the numbers are too small to permit any deduction; while of silk and hemp it may be said that, nearly all deligations previous to 1870 having been done with these substances, all deaths and all successes prior to that date belong to the first two lines of the table.

⁴ In the College of Surgeons Museum is a Hunterian preparation, No. 1701, Pathological Series, said by the dissector, Mr. Clift, to be an aneurism of the pudic artery outside the pelvis.

⁵ Archiv für klinische Chirurg., Bd. xi. S. 162, 1869.

which was an instance of aneurism by anastomosis, while another, recorded by Dr. Stoker, of Dublin,¹ is extremely doubtful, the observer of that case giving no account of symptoms or appearances. I omit both these cases, reducing Dr. Fischer's number to thirty-three. Since 1869, seven cases have been recorded,² making the number of known cases forty. Besides these, there are two instances of a rather different affection termed ischiadico-popliteal, one example of which was recorded in Guy's Hospital Reports,³ the other by Gallozzi.⁴ In this latter, especially, it is noted that the superficial femoral artery was very small, terminating as a little twig just after piercing the adductor magnus. The sciatic artery was large, ran down the back of the thigh with the nerve, and became the popliteal. In these cases the swelling began lower than in those now to be described. The usual aneurism of the buttock forms a tumor, circumscribed or diffused, at the side of that part, and some distance behind the great trochanter; the swelling may or may not pulsate; it usually has some sound, a whirr or a hum, which may in the same case be sometimes present and sometimes absent.

The disease is usually accompanied by very considerable pain, not at all confined to the site of tumefaction, but running forward on the dorsum ilii, downward on the back of the thigh and leg, and sometimes into the perineum. Severe cramps of the leg and sole of the foot are a frequent accompaniment. Thus several of the patients have at first complained of, and without due examination have been treated for, rheumatism, rheumatic gout, sciatica, and even vesical disease.

Aneurisms in this locality are very commonly, as we shall see, the result of injury; hence, they are frequently diffused, even those that were originally circumscribed being very liable to rupture and diffusion. While sacculated, the tumor is rarely larger than a hen's egg, but one or two have been the size of a child's head; when diffused, they may attain to any size, and may extend from the top of the ilium a long way down the thigh.⁵

Diagnosis.—Probably the nature of a rounded, circumscribed, murmuring and pulsating swelling at the side of the buttock, is, in spite of its depth, as easily recognizable as in any other situation; but the disease does not by any means always manifest itself thus, and when there is neither bruit nor pulsation, the diagnosis is undoubtedly difficult, so that many disastrous errors have been made. Aneurism of either the gluteal or sciatic artery is most likely to be confounded with abscess, tumor of bone, and perhaps with sciatic hernia.

Abscess in this situation is more common in young persons than in those beyond 25 or 30 years old. It may arise from hip disease, from caries of the lowest lumbar or sacral vertebrae, or from sacro-sciatic disease,⁶ as also from suppuration of the subgluteal bursa. A deep, circumscribed abscess in this situation is never a mere localized suppuration, but is combined with symptoms of caries at one or the other locality above named, the pus finding its way out of the pelvis along the pyriformis muscle through the sciatic notch. If the abscess be merely in the subgluteal bursa, it has little definition, is more widely diffused, and makes of the nates a sort of bag, which hangs lower without implicating the thigh than does an aneurism. If doubt remain (and this latter form of abscess may very closely simulate a diffused, non-pulsating

¹ Trans. of the Association of Fellows and Licentiates, etc., vol. i. p. 41, 1817.

² Bickersteth, Kade, Baher, Landi, Coluzzi, Scauffoni, and Gallozzi.

³ Hilton-Fagge, 1864.

⁴ Lo Sperimentale, febbrajo, 1874.

⁵ See John Bell's cases, and more recently Kade's case in St. Petersburg Med. Wochenschrift, 1876, No. 89.

⁶ See the author's work on Diseases of the Joints, in Wood's Library of Standard Medical Authors, p. 315, and the article on Joint Disease in this Encyclopædia.

aneurism) the aorta must be compressed and the variations in size of the tumor watched (see p. 846). If the case be still ambiguous, a fine exploratory trocar should be employed.

To distinguish between gluteal aneurism and *malignant tumor of bone*, is extremely difficult. They both may or may not pulsate; but a growth from bone alters the shape of the part by raising ridge-wise around its stalk the outer crust or table, and has generally within it osseous spiculæ. These characteristics have been already sufficiently pointed out (p. 847). I need only add, that examination through the rectum is an immense aid in diagnosis, and that if by the mere introduction of one finger no distinguishing marks can be discovered, it may be necessary, for reasons which will be given presently, to insert the whole hand.

Sciatic hernia is an extremely rare condition. If it be reducible while the aorta is unobstructed, there can be no difficulty in diagnosis; if irreducible, it will probably be, in part at least, flatulent, and on percussion will give the characteristic note. Impulse on coughing, though slight, is also to be detected, and the peculiar gurgle on pressure will almost always be felt. Moreover, though it may, as a rarity, be irreducible at the time of examination, rest in bed for a day or two will probably diminish its size, even if it do not entirely go back. I am not aware that in the records of surgery any case of incarcerated or strangulated sciatic or gluteal hernia has occurred.

The symptoms, history, and circumstances of gluteal aneurism are as follows. A large proportion of these cases are due to some form of injury, thus:—

Spontaneous	12
Penetrating wound	16
Falls and blows ¹	10
Caries (sacro-iliac) ²	2

A swelling, accompanied by pain and lameness, which comes on a few days after an injury, may easily be mistaken for an abscess; and proportionally to its frequency, more mistakes have been made in cases of this particular aneurism than of any other. In most of these, however, there is at first some sound, at one or another part of the tumor, and generally over the sciatic notch more distinctly than elsewhere. The surgeon should not be content with a single auscultation if there be no murmur, but should search, on several successive days and in different positions of the limb, both for sound and pulsation. The rock on which diagnosis is most easily wrecked, is when there exists an aneurism with neither pulsation nor bruit. The surgeon must endeavor to empty the tumor when the aorta is compressed. Even in doing this some cautions must be given, for an abscess, by gravitation, may be partially emptied by pressure from the outer parts into the interior of the pelvis; but this will be as easy when the aorta is free as when it is compressed. This in itself is diagnostic; for a tumor which can thus be rendered flaccid and small under compression of the aorta, but not otherwise, is clearly not an abscess. Examination by the rectum should in all cases be made. Generally the introduction of the finger merely is insufficient, but with the three outer fingers—or, when necessary, with the whole hand—the sciatic notch may be felt, as also the iliacs and a great part of the front of the sacrum. Now, in this way one may detect the roughened surface of caries, or, perhaps, an aneurismal prolongation into the pelvis, or one may feel the vessels to be normal; or, on the

¹ I have already called attention to the doubtful meaning of the word traumatic. It would certainly be greatly to the advantage of surgery if we had one word to indicate wound, and another to mean injury without wound.

² I think that in one of these cases the caries was due to and not produced by the aneurism; the other is, perhaps, as given in the text.

contrary, a bag of purulent fluid, fluctuating from without to within the cavity, may be discovered. The first condition only is absolutely diagnostic; the others, however, greatly aid. The same investigation should be made if there be doubt concerning some tumor of bone. It is hardly possible that such a tumor should be marked on the outside of the pelvis without giving some sign within the cavity. In many cases all care and acumen will still leave some ambiguity, which the use of a fine exploratory trocar will set aside. When thus employed, positive evidence—that is, the appearance of pus—must be obtained before any such adventurous measure as incision is practised.

Treatment.—Several methods of treatment are open to the surgeon, the most important being (1) Rest and expectancy, (2) Pressure, (3) Injection, (4) Opening the sac (Antyllus), (5) Tying the gluteal or the sciatic artery as it leaves the pelvis (Anel), and (6) Deligation of the internal iliac artery.

(1) The first (*expectant method*), provided the aneurism do not grow, may be carried on as long as the sufferer's patience will last; but these aneurisms do not long remain stationary.

(2) *Direct compression* and *proximal pressure* on the aorta have not proved of value. In one case,¹ indeed, a certain improvement took place; but in three years the aneurism returned.

(3) *Injection of a coagulating fluid* (perchloride of iron) has proved valuable when the aneurism has been distinctly sacculated.

(4) *Opening the sac* and tying the vessel below the tumor, and also above, that is, at its exit from the sciatic foramen, may be undertaken under certain circumstances. Thus if the disease have been produced by recent injury, it probably affects only some part of the artery lying outside the pelvis, in which case the procedure in question will be applicable; but even an aneurism thus produced, and the more likely if it be of some little standing—and still more probably if it be of spontaneous origin—may extend beyond these confines, and a portion of it may be within the pelvis, and thus beyond reach. If by any chance the Antyllian method were used in such a case, death could hardly be escaped; therefore no such operation should be undertaken unless previous rectal examination had shown the artery to be sound.

(5) *Anel's Method.*—If the vessel be found healthy, either deligation of the sciatic or gluteal, as the case may be, can be undertaken with some little prospect of success. In either procedure one of the vessels above should be commanded; the aorta can usually be efficiently compressed in a thin person; if the individual be stout, Davy's lever will insure entire, or almost entire, bloodlessness. My own experience of this instrument is not very favorable; it is apt to produce bruising and inflammation of the iliac vein. The surgeon undertaking either operation ought to know that the sac lies much nearer to the surface than would *a priori* be supposed: the gluteus becomes spread out over it, the fascia becomes much thinned, and even the fat of this region may, to a great extent, disappear. The aneurism may be divided by a constriction into two portions ("hour glass"), or may split into prolongations ("digitated") in the direction of branches. The mouth of a sciatic aneurism lies lower than that of a gluteal, and in attempting to secure the vessel after the method of Anel, much difficulty may be experienced in deciding which of the two arteries requires deligation.

(6) *Deligation of both the internal and common iliac arteries* has been practised for this aneurism, but the results are not encouraging; the latter operation would of course only be undertaken if the condition of the internal branch rendered the application of a ligature to it injudicious or very difficult.

¹ Riberi, *Giornale delle Scienze Med. di Torino*, 1833.

The results of these various methods are:—

	Cure.	Death.
Rest and expectancy	1 ¹	5
Pressure (direct and proximal)	0	2
Injection of perchloride of iron	4	2
Old operation (Antyllus)	4	1
Deligation of artery outside pelvis	2	2
“ internal iliac	6	10 ²
“ common iliac	0	2
Galvano puncture	0	1

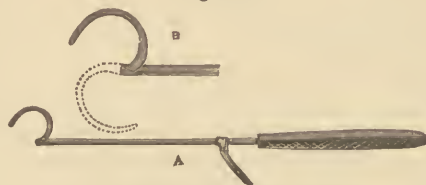
To tie either the upper part of the external, the internal, or the common iliac artery, the operator must go through the same steps up to the time of his reaching the vessel. The incision should commence a little below the level of the anterior superior spine of the ilium, and about an inch inside it; then it should be carried upward for from four to five inches, the cut, however, not running straight between these points, but sweeping backward with a free outward curve, so that the extent of skin passed over by the knife is considerably greater than the space between the ends of the incision. The outer muscle of the abdomen is thus brought into view, and may be divided in the same curve, and then the internal oblique and the transversalis are to be similarly dealt with. It is not necessary to use the director, certainly not for the outer two muscles; but each layer should be distinctly recognized. After division of the last-named muscle, the transversalis fascia is exposed; sometimes it is very thin in this place, and the operator may be in some doubt, but he must entirely orient himself before going on. Let him turn up the transversalis muscle, and, examining its deep surface, ascertain if the fascia have been incised with it. He should remember, too, that this structure is of a slightly bluish-gray—that between it and the peritoneum is an unevenly distributed layer of granular fat—and that one can dimly see the viscera through the serous membrane when bare, but not through the fascia. When he has decided that the structure in question is uncut, he must divide it on the director, and will find it easier to begin below, where it is thicker, than above, where it is thin and less distinct in structure. The peritoneum being exposed in the length and curve of the first incision, the surgeon now presses it gently towards the middle, taking care to separate it very carefully, and not too quickly, from the parts behind; if he be intending to tie the common iliac, he should aim at the upper margin of the sacrum; if one of the branches, a little lower: in the one case, he will carry his finger along the crest of the ilium and the parts above; in the other, along the back part of the iliac fossa. Thus going on, the operator, when his hand gets near the sacrum, feels the great artery beating in the depths of the wound; the ureter and the spermatic vessels will in all probability have remained attached to the peritoneum, and, being turned aside with it, are out of danger, but it is well to make sure of this by touch or sight before going further. Supposing that it is the common iliac which the surgeon intends to tie, he will find the artery lying just inside the psoas muscle, and may, by passing his finger gently downward, feel its bifurcation (the vessel, unless for very high aneurism, should be secured at its lower end), which will assure him that he is really at the intended spot. But the artery is still covered by a layer of fascia, which must be scratched through with a director, the aneurism needle, or, as I prefer, with the finger-nail. At this point, the operator must bear in mind, that on the right side the iliac vein lies outside, on the left, inside the artery; in other words, that the vein is to the right for both lateral halves of

¹ Spontaneous relapse.

² Five of these operations were undertaken in hopeless conditions.

the body; so also the needle must be passed on either side from right to left. A difficulty is experienced sometimes in getting the instrument sufficiently far around the vessel to release the ligature, or to arm the needle, as the case may be. I have devised a needle which obviates this trouble (Fig. 546). The

Fig. 546.



Aneurism needle with hinged end.

lower, curved end being mounted on the shank by a hinge, can be projected forward by pressure on the trigger; so that without moving the handle or body of the instrument, the eye can be made to pass around the vessel.¹ If the upper part of the external iliac is to be tied, the vessel will be found a little nearer the surface; on the left side, the vein is inside; on the right, behind the artery; the needle is used lower down in the wound.

The short trunk, termed internal iliac or hypogastric, lies a little further inwards; the peritoneum must be pushed back nearly to the middle line, the bifurcation of the common trunk distinctly felt, and the vessel traced thence in front of the sacro-iliac joint; the artery should be tied as low as is feasible. The way in which, on the left side, it crosses over the vein must be borne in mind, lest the instrument, being carried too far back, should wound or include that vessel.

ABDOMINAL ANEURISM.

The description of tying the internal iliac artery has forestalled somewhat what is to be said in connection with this subject, but to have separated it from deligation of the other iliaes would have necessitated a troublesome repetition, whereas a retrospect only is now needed. The internal iliac may require ligature for aneurism about the buttock; the lower part of the external iliac for femoral aneurism; the upper part of the same vessel for aneurism in the iliac fossa; and, if the sac of the aneurism rise high, it may even be necessary to occlude the common iliac just above its bifurcation.

But the latter vessel may also be tied, or, at least, the operation comes into consideration, in cases of aneurism lying somewhat low in the abdomen. The division of the aorta into the common iliaes takes place below the middle of the fourth lumbar vertebra, and clinically, and on the living body, may be taken to lie about three-quarters of an inch below the umbilicus; hence we may roughly assume, unless evidence to the contrary be adduced, that aneurisms pulsating below that point are of the common iliac artery, and those above it of the abdominal aorta, or of one of its branches; the branch most often thus affected is the celiac axis, the next the superior mesenteric.

A few words must here be said concerning *pulsating tumors of the abdomen* and their diagnosis. It is well known that, in some persons, pulsations of the abdominal aorta may be felt on the surface of the abdomen with startling

¹ This instrument was devised for tying the subclavian artery in a person whose clavicle was much raised.

distinctness; especially is this the case with hysterical young women, and also in cases of albuminuria. The normal line in which this aortic pulse may be felt, with the unaltered beat of the femorals, should prevent any mistake as to the diagnosis. But the fact that such an exaggeration of beat may, under certain circumstances, occur, shows that caution is necessary in pronouncing as to the nature of any tumor overlying the aorta, even though it pulsate very strongly. Bruit is very frequently absent in abdominal aneurism; while a merely hysterical, pulsating aorta may possess a distinct, though not loud, murmur. No conclusion, save in very evident and plain cases, should be formed until a purge and an enema have thoroughly cleared out the bowels. The examination should be made, not merely while the patient is on his back, but also while he is on his side; so that the surgeon, gently kneading the intestines away, may get his hand more directly on the vessel, and so that any intestinal impaction, or mesenteric or omental tumor, may fall away from the front of the vessel. If, under these circumstances, an ovoid or globular pulsating tumor remain stationary, or nearly so, the suspicion of its being aneurismal is in so far confirmed; but it must be remembered that malignant tumors of the lumbar spine or glands, or of the kidney, and even a pyo-nephrosis or a hydro-nephrosis, may pulsate;¹ and the possible presence of each of these conditions must be eliminated by careful and repeated examination.²

The pressure symptoms of abdominal aneurism, being due to compression of certain viscera, or of their ducts, are not very dissimilar to those caused by disease of the organs themselves. Thus, we may have pain in the back, with caries of the spine, and even psoas abscess; loss of flesh, sickness, distension, etc., from intestinal pressure; the same set of symptoms, with severe jaundice, from obstruction of the hepatic ducts; or intense renal troubles from involvement of the ureter. Such conditions, if taken alone, are not in any way characteristic; but if conjoined with the presence of a pulsating tumor, they may greatly aid diagnosis.

Aneurism of a branch at a little distance from the parent trunk is distinguishable by the mobility of the whole tumor; this is more especially the case if either mesenteric artery be involved, but if the aneurism spring from a branch close to the main vessel, and a portion of it involve the actual mouth of the artery, no such distinction can be drawn.

The *treatment* of abdominal aneurism is by no means attended by very satisfactory results. The method of Valsalva should first be tried, without the bleedings, or, at all events, without the copious and repeated bleedings recommended by that surgeon. A certain hopefulness is imparted by the fact that a certain number of these aneurisms, some of them unsuspected during life, have undergone spontaneous cure. The rest should be entire, the patient being prohibited from rising or turning in bed without assistance; even the thighs and legs should be kept very still. Some aid, and in such cases even the slightest assistance should be sought, may be obtained by raising the foot of the couch so that the pelvis and nether limbs may be some inches above the shoulders, and that thus the force of the blood-stream may be diminished by gravity. Atropia, aconite, or digitalis, may be given alternately according to circumstances, and I have had reason to assign much benefit to their use. All these drugs must be administered with caution, for though slight nausea may be induced, emesis is to be avoided; a single act of

¹ Occasionally, though very rarely, abdominal aneurism does not pulsate; under which circumstances it may be almost impossible to make a diagnosis, save after long watching.

² Some caution should be given concerning much kneading or pressure on these tumors. Too great an amount of force may, and indeed has, caused rupture.

vomiting may, especially if the aneurism be placed high, undo the work of many months, and may perhaps even add a fresh increment to the disease.¹

After days of this treatment, or even after weeks, if progress be slow, only one of three courses is open to the surgeon: (1) To leave the patient to his rapidly approaching fate; (2) To try the effect of pressure; (3) To ligature the aorta. The choice between these depends in great measure on the place whence the tumor springs, and the height in the abdomen to which it rises.

Distal pressure has never yet proved of advantage in aneurism of the abdominal aorta; so many branches are given off from this short tract of the vessel, that it does not seem theoretically possible to sufficiently restrict the circulation by means² which practically have proved unavailing. I know of but three cases in which this plan has been tried: one proved fatal by bruising of the peritoneum and intestine, and in the other two no benefit accrued.

Proximal pressure may be applied in abdominal aneurism, provided that the sac be placed low enough to admit a tourniquet pad between it and the diaphragm; in other words, if it be on a level with or below the inferior mesenteric artery, and if its beat be not much above the umbilicus. Thus aneurisms of the common iliac, or of the upper part of the external iliac arteries, may be so treated, as well as those of the aorta a little above its bifurcation; but five-sixths of aortic abdominal aneurisms arise from the part whence the celiac axis and the superior mesenteric artery are given off, that is to say, so high that the use of proximal pressure is impossible.³

To Dr. Murray, of Newcastle,⁴ belongs the credit not only of a first attempt, but also of a first success in this method. Dr. Moxon and Mr. Durham afterwards cured a case of abdominal, probably mesenteric, aneurism by proximal pressure continued uninterruptedly for ten and a half hours.⁵

The instrument employed is either the abdominal tourniquet of Dr. Pancoast (Fig. 111, Vol. I. p. 574), or the aortic compressor of Mr. Lister (Fig. 112, *Ibid.*). The patient must be prepared by a thorough cleansing of the bowels with medicine and enema. The safest place for the application of the instrument is probably about midway between the umbilicus and the scaphoid cartilage, or a little higher, but not as high as to endanger either the pancreas or the duodenum where they cross the aorta. The intestines should be carefully kneaded and pressed away with the hand as much as possible, and then the fingers are to press the abdominal wall backwards towards the spine, and the pad is to be screwed down upon them. Then, when the fingers are withdrawn, the tourniquet is to be screwed down very slowly, so as to give the viscera ample time to escape to either side.⁶ No stronger pressure than is needed to command the pulsation of the aneurism should be employed, and if that be persistent, it may be wiser to permit a slight wave than to use very much force. A fair guide will be the behavior of the femoral artery, whose beat is often annulled before that of the aneurism. Owing to the want of circulation in the nether limbs, good covering with artificial warmth must be supplied. Since pressure sufficient for the purpose cannot possibly be borne by a conscious patient, some form of anæsthetic must be employed; and since fits of severe vomiting are to be avoided, such agents as are least likely to induce that condition should be chosen; and also, since the anæsthesia, though it need not be deep, must be prolonged, it is generally desirable to

¹ As far as I can find, three cases only have permanently benefited by this treatment.

² This is not strictly correct in regard to the common iliac, but the internal iliac would afford current enough to render compression of the external iliac futile.

³ See Sibson's Medical Anatomy, p. 58.

⁴ Medico-Chirurgical Transactions, vol. xlvii. p. 187.

⁵ *Ibid.*, vol. lv. p. 21.

⁶ Even when the pressure is made quite low down, a coil of intestine may become involved, as in Bryant's case (*Med.-Chir. Trans.*, vol. lv. p. 225).

vary these, so as to neither too greatly depress nor excite the heart's action. It must also be remembered that by forcing the abdominal muscles against the spine, the movements of the diaphragm become immensely impeded. The action of the heart is apt to be embarrassed, not merely from this cause, but also because a great part of the blood which ought to flow through the abdominal aorta to the lower limbs, is now retained in the upper aorta and its branches; there is in the upper part of the body a local plethora, yet the fear entertained some years ago, that the brain might suffer from this mode of treatment, appears to be chimerical.

One very imminent danger, which has been illustrated by more than one death, is bruising of the peritoneum, of certain viscera, or of both. The pancreas and duodenum have both been almost pulpetied by incautious application of the tourniquet at a point too high for safety. Other portions of the intestine have also been severely injured. Below the duodenum, no fixed viscus overlies the aorta, and here, partly by kneading the intestines away with the fingers, partly by screwing the pad very slowly down, so as to press those parts away, pressure upon the bowel may sometimes be avoided; that on the peritoneal surfaces is of course unavoidable. The compression must be strong enough to annul, if possible, all pulsation of the aneurism, and that of the femorals at the groin must also be suppressed. The femoral pulse may be taken as a guide to show when the compression is sufficient. In some cases, the aneurismal pulse will not entirely disappear, but when the femorals have ceased to beat, it is not safe to turn the screw much further.¹

Pressure made in this way has been kept up with the aid of anæsthesia for five, ten, and ten and a half hours.² During the whole time of treatment, the greatest watchfulness must be exercised over the condition of the patient, in several directions—as to the effect of the anæsthetic, the state of circulation and respiration, the condition of the lower extremities, and any movements which might cause the instrument to slip. It will be necessary, all this time, to watch for pulsation both in the femorals and in the tumor; if the aneurism, during maintenance of pressure, get harder and smaller, much hope may be entertained that a cure is going on; but the pressure should still be continued for at least four or five hours. When compression is stopped, the tumor may appear unchanged; and then, if the patient can bear it, a further attempt may be made.³ The aneurism may have but very slight or no pulsation, but this may, in a few hours, to a certain extent, return. Under these circumstances it is wise to leave the patient at rest: the cure once begun may complete itself, and a non-increase of pulsation shows that the case is doing well. This consecutive mode of cure followed in the case of Durham's and Moxon's patient.

The recorded cases treated in this way are but few: doubtless more have failed than are made available by publication, but we may conclude with almost complete certainty that all successful instances are known. Ten cases are recorded, of which five were successful; in one of these the aneurism was of the external iliac artery.⁴ In five cases the treatment failed, death resulting in four.⁵ All the deaths were due to peritonitis and bruising of the

¹ Entire suppression of urine during pressure cannot be without danger; hæmaturia is less important, unless from injury to the kidney.

² Murray, Heath (of Sunderland), and Durham.

³ In the famous Sunderland case, pressure, not quite continuous, was employed for ten hours, when the patient fainted, the tumor seeming in no wise improved; he submitted to a further trial without any anæsthetic, and the aneurism solidified in twenty minutes. (*Brit. Med. Journal*, Oct. 5, 1867.)

⁴ Wheelhouse, *Clinical Society's Trans.*, vol. viii. p. 57.

⁵ One of these is unpublished; it occurred in the practice of Mr. Hird, at the Charing Cross Hospital.

abdominal contents. Of the fatal cases, one involved the superior mesenteric artery. In a non-fatal case gangrene resulted, the external iliac was tied, and amputation performed. Agnew records a successful compression of the common iliac for aneurism of the external iliac artery.¹ Three cases of distal compression of the aorta have failed, one under Marshall's, and another under my own care, while the third² terminated fatally from the usual cause, bruising of the viscera and peritoneum.

Deligation of the abdominal aorta has hitherto, in the human subject, proved invariably fatal. Whether surgery is permanently to accept the defeat, we shall consider in the sequel.

Astley Cooper first performed this operation in June, 1817, on a man thirty-eight years old, who, having aneurism of the external iliac artery, suffered profuse hemorrhage after pressure, which involved the sac. The operation was performed through the peritoneum, and the man lived 40 hours. The latest case is that recorded by Czerny, of Heidelberg, in 1879, for hemorrhage after extirpation of the kidney. In all, there are on record 10 cases: 4 undertaken for hemorrhage (2 secondary, in aneurism), and 6 for aneurism without hemorrhage. Cases of the former class are very unfavorable, even when much smaller vessels are tied. Of these 10 cases 6 were, if the phrase be allowable, foredoomed to death, either by concomitant disease, or by mishaps during the operation. Taking these cases in chronological order, the complications were:—

1. Escape of inflated intestines; breakage of aneurism needle, and long search for it among folds of mesentery; insufficient care in closing bleeding vessels,	Death in 4 hours.
2. Bladder disease; dilated ureter	" " 23 "
3. Bursting the sac by manipulation; inclusion of the ureter in the ligature	" " 11½ "
4. Fatty degeneration of heart ³	" " 13 "
5. Very complicated injury, caused by the previous condition rather than by the operation, which terminated in a different procedure from that originally intended	" " 26 "
6. Malignant disease of kidney; nephrectomy	" " 10 "

A very unfortunate list, of which it can only be said, that in four of the cases death would probably have followed smaller operations, while in the two others either inherent difficulties or insufficient skill, rather than the necessary sequelæ, led to a fatal result.⁴

In the only four cases which were free from unfortunate and unnecessary complications, the patients survived for 40 hours, 43 hours, 65 hours, and 10 days 21 hours respectively—lapses of time more than sufficient to show that the chief theoretic objection, viz., oppression of brain and heart through overfulness of blood, is no necessary result of the operation, even though, as in Cooper's case, the vessel be tied above the duodenum. The causes of death in these four cases are, therefore, of the highest degree of importance; unfortunately they are not all obtainable.

The first patient (Cooper's) died unmistakably of peritonitis; nor can we take as a negative its apparent absence on post-mortem examination, because the earliest signs of that condition are not easily detected, while in this in-

¹ Philadelphia Medical Times, Sept. 4, 1875.

² Bryant, *Medico-Chirurg Trans.*, vol. lv. p. 225.

³ A more necessarily fatal complication can hardly be conceived.

⁴ The subject of the fifth case in the above list (Czerny's, of Vienna) died of sloughing of the injured part, together with the admission of air or gas into the open veins. The morning after the operation, he smoked a cigar with pleasure.

stance the symptoms were exceedingly characteristic. (Intra-peritoneal operation.)¹

The next patient (South's) lived 43 hours. The case is very insufficiently reported, the only note that I can find of it being: "The young man went on remarkably well after it, but he died on Monday morning, surviving the operation 43 hours." (Extra-peritoneal.)²

P. Heron Watson's patient survived 63 hours. The operation was undertaken for secondary hemorrhage, after deligation of the common iliac. This case also is very shortly reported. The patient died of exhaustion. (Intra-peritoneal.)³

Monteiro's patient lived close upon 11 days, and died of secondary hemorrhage.⁴ If the operator had been possessed of one of the fresh animal ligatures recently introduced, the man would probably have recovered.

It must, therefore, be concluded that deligation of the abdominal aorta has hitherto been very unfortunate as to the accompaniments of the cases in which it has been tried. It does not deserve, therefore, to be condemned and banished, but under pressing circumstances may be resorted to, the operator employing the extra-peritoneal method, and using such a ligature as will obviate the risk of secondary hemorrhage. This is demonstrable from the results of Monteiro's, and in a less degree by those of the other three comparatively successful cases.⁵

ANEURISMS OF THE UPPER EXTREMITY.

ANEURISMS OF THE PALM AND WRIST.—These are nearly always traumatic, and may be exceedingly troublesome, since the very free inosculation of vessels occasionally frustrates attempts at cure. All the means which have been detailed in previous sections are, however, available. But the surgeon would probably first try either the Esmarch bandage, or some form of pressure on the brachial artery. Flexion, with a pad in the bend of the elbow, has been successful in arresting hemorrhage and in curing consecutive aneurisms. Deligation of one, or of more than one, of the afferent arteries, is but a slight operation, and is very usually successful. Incising the sac and securing both ends has also availed; but three cases are on record in which, after such an operation, the palm suppurated, the carpus became carious, and, in two, amputation was performed. Nor can I commend extirpation by chloride of zinc or other cautery. If none of the various forms of pressure cures the disease, deligation is the least severe method, and the one most unlikely to be followed by evil consequences.

For an aneurism in the palm, which will not yield to compression, it is probably the best practice to tie both the radial and ulnar arteries a little above the wrist.⁶ The operation on either vessel, low down, is extremely simple. The radial is easily accessible throughout its course.

¹ Cooper and Travers, *Surgical Essays*, Part i, p. 201.

² *Lancet*, 1856, vol. ii. p. 47.

³ *British Medical Journal*, 1869, vol. ii. p. 216.

⁴ Schmidt's *Jahrbucher*, Bd. xxxvii. S. 85.

⁵ Space will not allow me to consider here all the arguments that have been adduced either for or against the operation. Pirogoff's well-known experiments (*Waller und v. Gräfe's Journal*, Bd. xxvii. S. 122), and those of Kast in his excellent paper (*Zeitschrift für Chirurgie*, Bd. xii. S. 405), show that the collateral circulation becomes established, and that the supposed injurious effects on spinal cord and brain—the one from excess, the other from absence of blood—are chimerical.

⁶ If any prolonged pressure has been made upon these vessels, the deep branch running to the carpus from the anterior interosseous, and probably other side channels, will supply too much blood to the part. In a case under my care—of hemorrhage from a wound of the palmar arch, caused by the bursting of a soda-water bottle—the vessel had twice been tied in the wound.

Ligation of the Radial Artery above the Wrist.—Midway between the tendons of the supinator longus and flexor carpi radialis, a longitudinal incision, from an inch to an inch and a half in length, should expose the fascia of the arm, and with the finger moved from side to side the skin and subjacent tissue should be pushed away, so that a little breadth for examination is obtained. Through the thin but firm fascia, the artery and its companion veins are usually visible; if not, the vessel may be felt pulsating. Just at the inside of these parts, the fascia may be pinched up with forceps, opened, and slit up on a director to the length of the first incision. The nerve has left the vessel at this point, and does not require consideration. If the operator think it necessary, which it is not, he may separate the companion veins.

Ligation of the Radial Artery in its Upper Portion.—The operation on the vessel higher up is quite as simple. The artery takes a straight course from the biceps tendon to the inner edge of the radial styloid process. In the middle third it may be overlapped by the belly of the supinator longus, which may, after division of the fascia, be drawn outwards. The nerve, which is nearer the vessel in the middle third than elsewhere, should be pushed in the same direction, and the needle is to be introduced between it and the artery.

Ligation of the Ulnar Artery.—To tie the ulnar artery above the wrist, the tendon of the carpal flexor may be taken as the guide. The incision must be made just outside its outer edge, deep enough to lay it bare, and to enable an assistant to hold it inward with a blunt hook. The artery and the nerve will then be seen, the latter on the inner side; but the vessel is not yet bare, being held down to the common flexor by a fascial covering, which must be divided.¹

In the middle third of the forearm, the ulnar artery may be tied by making an incision two inches long, in a line drawn from the inner condyle to the pisiform bone. This should expose the deep fascia, which is also to be divided along the aponeurotic edge of the flexor carpi ulnaris, beneath which the artery will be found, tied only to the underlying muscular fibres by some loose cellular tissue. The needle must be passed from within outwards. An operation for tying the ulnar in its upper third has been described, but should not be practised. Either of the above operations may be employed for an aneurism lying two inches above the carpus, each for its respective vessel. But if the disease be situated lower than this, deligation of one vessel only is usually insufficient; therefore, if we operate in the forearm at all, two wounds have to be made. In my experience, however, deligation of the brachial artery, not too high, is preferable, and will cure an aneurism at the wrist, and even check hemorrhage from the palm.

CASE XVI.—J., aged 7, fell, with a bottle in his hand, and divided the ulnar artery about three-quarters of an inch from the pisiform bone, on June 3, 1881. A pad and firm pressure checked the bleeding, but in five days a pulsating tumor formed in the wound; on the seventh day it burst. My house surgeon tied the ulnar artery immediately, above and below. This device answered well for another period of five days, and then pulsation recurred. Flexion failed to check the beat of the tumor. On the 13th of June, the consecutive aneurism was the size of a French olive, and beat violently in the still open wound. I found no pulse whatever in the ulnar artery, on which the aneurism was situated. Pressure on the radial, just above the wrist, entirely stopped pulsation of the tumor. Flexion had no such influence, unless a pad was placed in the

Bleeding soon recurred, and the house surgeon fastened a pad of cork on both radial and ulnar artery. This device was efficient for five days only. On a return of hemorrhage I ascertained, by careful examination, that the pressure quite commanded the pulse in both vessels, and yet the bleeding was pretty free. I tied the brachial artery, but even then, slight though quite unimportant oozing continued for thirty-six hours.

¹ There are three nerves on this aspect of the forearm. As a mnemonic, I may say that each artery lies between the median and the nerve of its own name.

bend of the elbow. This device was adopted. During the night the aneurism burst, a good deal of blood being lost before discovery of the accident. Mr. Taylor tied the brachial artery about the middle, with the thickest form of catgut which is made antiseptic.

15th. Some pulse in radial and ulnar arteries, which towards evening became strong.

17th. Pulse of both wrists alike. Flexion of elbow again resorted to.

20th. I had directed Mr. Taylor, if bleeding recurred, to send for me; accordingly, on this date, I was summoned. Hemorrhage had set in, both from the accidental and from the operation wound. It was temporarily restrained by an Esmarch cord. On examining the wound, I found, lying on the artery, the knot of a catgut ligature—the loop which ought to have been surrounding the vessel had entirely disappeared. There was an opening in the vascular coats running about one-third around the tube. I tied above and below this opening with an ox aorta ligature, and cut the ends short.¹ After this no bad symptom occurred, and in a fortnight the lad was convalescent, playing about the ward. Some slight pulsation in the radial, at the wrist, was detected on the 9th of July; it slowly increased, but was not strong when the patient left the hospital on the 12th.

Ligation of the Brachial Artery at the Elbow.—To tie the brachial artery at the bend of the elbow is very easy; taking the biceps tendon for his guide, the operator makes along its inner edge an incision about $1\frac{1}{2}$ inches long, and slipping a director beneath the fascia of the same name, slits it up; he will thus expose the artery, lying between the tendon and the median nerve; the needle should be slipped in between the nerve and artery. It is not always possible to avoid the median-basilic vein, even although it be visible; if it be divided, it should be tied at once. This operation is required in cases of arterio-venous aneurism at the bend of the elbow, but should not be employed for aneurisms lower down, since the wound is likely to terminate in suppurative, and in burrowing of pus along the bicipital tendon into deep parts.

BRACHIAL ANEURISM.—The brachial artery sometimes develops an aneurism at or near the bend of the elbow, as the result of a wound, but rarely spontaneously. The disease may be cured by using the Esmarch bandage, or by indirect pressure on the vessel above; but both procedures, especially if complete occlusion is aimed at, are very painful. In a few cases the tendency to spontaneous cure is so great that an occasional application of digital pressure, either by the patient himself or by assistants, will have all the desired effect. If this do not soon follow, or promise to follow, it is better not to persevere too long, as continued pressure over the median nerve becomes unbearable, and may leave the limb for months in a painful and rather useless condition.

Ligation of Brachial Artery.—The brachial artery may be easily reached in any part of its course—lying inside the biceps in the lower two thirds; in its upper third, inside the coraco-brachialis muscle. If the operator be accorded by the disease liberty to choose the spot at which he will tie the vessel, a point a little below the middle of the arm is the best. The incision, which at this point need not be more than two inches long, is made to follow the inner margin of the biceps, and then, either on the director or otherwise, the fascia of the arm is slit up to the same extent; this exposes the median nerve, which covers the artery, and which may be drawn to either side, preferably to the inner, since the basilic vein lies on that side, and both nerve

¹ This operation, seeing that the wound had been exposed before I arrived, was not done under the spray; although the parts were washed out with a five per cent. solution of carbolic acid, suppuration, not excessive, took place; but nothing more was ever seen of the ligatures.

and vein are thus avoided, while by passing the aneurism needle from that aspect, the veins which surround the vessel are easily separated with the end of the instrument. I would point out that the edge of the biceps should be the point aimed at—even though the artery may be felt beating a little further out—because by cutting on the edge of the muscle, the basilic vein is avoided. To make the more sure of the position, the upper arm should not rest against anything,¹ but should be held or supported by the forearm; it should be kept at more than a right angle to the trunk, with the elbow straight. If these precautions are observed, there is no difficulty in the operation.

Let it, however, be remembered that high division is not very unusual; when it occurs it is safe to tie both the branches, since recurrence of pulsation and relapse would most likely follow deligation of one only. The operator must not forget two points with regard to the median nerve; the one, that the artery sometimes lies over it, and would be endangered by over-bold use of the knife; the other, that the nerve, even when in its normal place, beats so strongly with a pulse communicated by the vessel, that it may by the inexperienced be tied in mistake.

Ligation of Axillary Artery.—By throwing the arm well up, in a line with the trunk, the axillary artery becomes accessible in a considerable part of its length, and may be successfully ligated almost as high as the head of the humerus; indeed, I have tied the vessel here for troubles other than those in question. For aneurism it is not desirable to operate high up on the axillary artery, and the arm, under these circumstances, may be placed at right angles with the trunk. In the last third of its course, the vessel is easily reached by making an incision in the humeral aspect of the axilla, parallel to the border of the pectoralis and a wide finger's breadth from it; this should reach, but not divide, the fascia forming the floor of the space, which may be lifted on the forceps, incised with the blade held flat-wise, and then split up on the director. Close beneath the fascia lies the axillary vein, which should be caught with a blunt hook, and drawn to the back of the wound. Lying amid loose cellular tissue are the nerves, which partly conceal the artery; upon it and on its outer side are the median, crossing it very obliquely, the ulnar, and the internal cutaneous; the two latter may be taken up and placed in charge of the hook which is already holding the vein, while the median is pressed by a retractor against the coraco-brachialis muscle. Then the needle must be passed, keeping it close to the artery so as to avoid the musculo-spiral nerve, which lies just beneath. This operation is adapted for aneurisms above the middle of the arm.

Deligation of the brachial, or of the lower part of the axillary artery, for aneurism, is so very generally successful, and is so slight an operation, that but a small number of cases are published. Moreover, since aneurisms of the arm are not very common, the operation is rarely required. I find but ten cases recorded: in all the disease was cured; in one, secondary hemorrhage was easily controlled by a pad; and in one a high division of the artery slightly embarrassed the surgeon, who, after tying one vessel, found that the aneurism still pulsated, whereupon he sought and ligatured the other branch.

In hospital records for the last ten years, I find but six cases, all of which were successful; also, by a strange coincidence, six other aneurisms of the brachial, four of which were cured by tourniquet pressure, and two by the use of the Esmarch bandage and cord.

The axillary artery has been ligatured higher up, but I would point out that to tie this vessel above the pectoralis minor, for axillary aneurism, appears

¹ When the back of the arm rests on the table, the triceps is pushed forward, and even the biceps may be somewhat displaced; hence a certain difficulty in finding the artery.

entirely inadmissible. If the disease be so situated as to throw the clavicle upward, and thus to cover the third part of the subclavian, the tract of vessel above the smaller pectoral is not likely to be unaffected. Hence it is better to aim at the artery higher up, and the operation for tying the last part of the subclavian leaves the surgeon free to go still higher, namely, to the second part, if it be necessary.¹

For wound or rupture of the vessel, such an operation may perhaps be undertaken, though the old operation, as modified and practised by Mr. Syme, would in most cases be preferable (see p. 852). The operation may be performed in one of three methods: that of Chamberlaine, that of Roux, and that of Guthrie.

(1) Chamberlaine's operation may be thus described: An incision, beginning about two and a half inches from the inner end of the clavicle, is to run along its lower margin to the deltoid tubercle. The muscular fibres of the pectoralis major, and a few from the inner part of the deltoid, are thus exposed, and, just beneath the bone, the small triangular gap which here separates the two muscles; running into this interval the cephalic vein is seen, together with certain branches of the acromio-thoracic artery. The loose, but rather strong fascia which fills this gap may be pinched up with forceps on the inner side of the above named vein, and close to the edge of the pectoralis. A little notch having been made, without letting the forceps lose their grip, the surgeon insinuates a director under the pectoralis, and quite close to the clavicle; upon this the muscle is divided for the requisite distance. Probably at this stage one or more arteries will require tying. The next step is the very delicate one of opening the costo-coracoid membrane without dividing the axillary vein; in some subjects this fascia may be torn with the finger, but in others it is more tough, and any great amount of force might rend the vessel; if it be necessary to use the knife, the safest course is to look for the cephalic vein, and to divide the membrane just in the angle between it and the inner edge of the smaller pectoral. The artery may now be seen, but it lies deep, crossed at its upper part by the cephalic vein, and having the axillary vein on its inner, and the brachial nerves chiefly on its outer side; the needle must be passed from within outwards, and kept very close to the artery.

(2) Roux is said² to have tied this part of the axillary artery through the delto-pectoral interval, without division of muscle; the operation is feasible, and I have often for the sake of practice done it on the dead subject; but it would be dangerous, and is not to be recommended.

(3) In these methods of operating, only a limited part of the vessel is exposed, and if, in a case of rupture or wound, it were desirable to see more of the artery, this could only be effected by dividing the pectoralis minor, a procedure which, considering that the larger muscle would have been already in part cut through, would produce much mutilation. Hence it may in some cases be well to follow Mr. Guthrie's plan. It is, however, one not devoid of danger, and it also inflicts considerable injury upon neighboring parts; but Mr. Guthrie (as witness his proposed method for tying the posterior tibial) appears to have had a strong partiality for making large wounds. He advises an incision from the edge of the axilla to just below the acromion, and division of the large pectoral in the same direction; this of course exposes all the parts in the axilla, and if, as he advises, the lesser pectoral be also severed, the vessel may be tied in any part of its course. Great caution to avoid the axillary vein would be required. All these operations must almost inevitably give rise to

¹ I have tied the third part of the subclavian when the clavicle was raised as high as it well could be, with, it is true, certain difficulties which might have been avoided had I at that time possessed the needle depicted at p. 926.

² Quarante Années, etc., t. ii. p. 133.

much trouble about the axilla, and generally to widespread suppuration. The cases in which they are justifiable must be very few.

AXILLARY ANEURISM.—This is frequently due to traumatism—even the sacculated variety is in general a sequela of over-exertion, or of attempts to reduce dislocation (which also occasionally rupture all the coats of the vessel)—but it is also sometimes spontaneous. The loose structure of the surrounding tissue causes the tumor to grow rapidly to a large, even to a very large, size. When situated high in the vessel, considerable elevation of the shoulder is caused by the mechanical filling of the axillary space.¹ Partly in consequence of the loose character of the surrounding tissue, partly from proximity of the heart, this form of aneurism runs its course rapidly. Its natural termination is rupture into the axillary cavity, causing enormous swelling and opening outwards by a slough of the skin; or it may spread along the vessel upwards to become a subclavio-axillary aneurism, and then to burst into the areolar tissue of the neck, or into the pleura. These dangers, and the rapidity of their advent, render energetic treatment imperative.

Diet and Rest.—This mode of treatment is unsatisfactory. Some very small number of cases may have been benefited by it, but I find no record of any having been thus cured.

Manipulation has not been successful in this form of aneurism; but it may be attempted if the tumor involve also the subclavian, and especially if it be of the left side. A clot, if it were detached from the upper part, might become impacted below. The treatment belongs eminently to that sort which might be called, if the expression were allowable, “hit or miss” (see p. 869).

Proximal pressure, that is to say, compression of the third part of the subclavian on the first rib, may occasionally succeed, but is very much more likely to fail. Both Mr. Holmes and Mr. Erichsen seem to have persuaded themselves² that compression of this vessel is not difficult. My own experience is, that in cases of large axillary aneurism raising the shoulder, compression of the subclavian is impossible, save for a few seconds. Syme, in order to effect this object, had to divide the skin and cervical fascia. In Poland's, and in other cases, an abnormally high course of the vessel permitted such pressure, but these favorable circumstances must, as Mr. Poland himself pointed out,³ be very exceptional. Mr. Holmes speaks of the benefits to be expected from pressure with much more confidence than I can. He is able to cite 5 cases of cure—by Turet, Vanzetti, Cooper Forster, Peatson, and Rizzoli. The third of these was effected in two sittings by the rapid method, with the aid of an anæsthetic, under circumstances unlikely to recur. The treatment in Peatson's case occupied three months; in Rizzoli's, apparently, somewhat longer.

Nevertheless, unless the position of the clavicle render compression of the subclavian artery evidently impossible, it is the surgeon's duty to make reasonable, but not exaggerated efforts to effect a cure by such means. Unaided fingers can rarely be trusted, but a Cole's compressor will bestow additional power. This is an instrument shaped like an office seal; it has a round, or, if preferred, a pistol-shaped handle, whence projects a shank or staff, and at the

¹ Mr. Spence promulgated the idea that this lifting of the shoulder might also be due to neuro-muscular phenomena, to irritation by the tumor on the nerves of the plexus, producing muscular contraction. He seems to have momentarily lost sight of the fact that the elevators of the shoulder, the trapezius and serratus magnus being respectively supplied by the spinal accessory and posterior thoracic nerve, both originating high above the clavicle, are withdrawn from such influence.

² System of Surgery, vol. iii. p. 555, and Science and Art of Surgery, vol. ii. p. 120.

³ Guy's Hospital Reports, 1871.

other end an oval pad. The shank, which is cylindrical, consists of two tubes, the one sliding within the other; they are kept from colliding by insertion within the tube of a strong spiral spring; the arrangement mitigating the rigidity and harshness of pressure, renders it somewhat more bearable. The compressor must extend beyond the patient's head, so that when he places the pad of the instrument on the proper spot, and leans a little forward, some of his bodily weight may impinge upon the vessel. The use of an anæsthetic will be very generally desirable, for proximity of large nerve trunks renders the treatment excessively painful. All the more, therefore, because the patient is unconscious, must the surgeon be cautious; injury to the vessel—eschar—even suppuration produced at this place—would be most detrimental, since the region available for this, and in case of its failure for any other method of treatment, is very small.

Although few cases of attempts to cure axillary aneurism by pressure have been recorded, I am aware of its having been frequently attempted. Some statistics have been already given: I find that among hospital cases, in the last ten years, five only are recorded as having been thus treated; of these, one (Cooper Forster) was successful, and one other doubtfully so; in one, the arm was paralyzed, and remained useless when seen many months afterwards.

Distal and direct pressure have not proved of any avail in the treatment of axillary aneurism. *Galvano-puncture*, or the injection of the *perchloride of iron*, might be tried in desperate cases, that is, where circumstances forbade the use of the ligature.

Ligation of Third Part of Subclavian Artery.—The subclavian artery in its third part is, in many cases, very easy to tie, and that with a very slight loss of blood—less indeed than may follow a tooth extraction; in other cases, although the vessel may be reached with facility, it is difficult to get a ligature around it. The method whereby this ease and bloodlessness may be attained is as follows: The patient should be placed on his back, with his shoulders somewhat raised, his head thrown a little back, and his arm separated at about a half right angle from his side. The surgeon places himself between the trunk and the arm, and notes well the place where the sterno-mastoid arises from the clavicle, and the somewhat variable position of the external jugular vein; then, placing his left hand on the larger pectoral, he draws down the integuments, and passes his knife along the clavicle, from an inch outside its sternal end to the insertion of the trapezius.¹ The skin is now to be relaxed, when the line of incision rises above the clavicle. The external jugular vein generally lies near the inner corner of this wound, and may be guarded from danger by holding it with a retractor against the outer edge of the sterno-mastoid muscle. Should it be further outward, the best and safest course is to free it from the fascia, tie it in two places, and divide it between the ligatures.² The incision is now to be placed so that its lower margin lies just below the upper border of the clavicle, along which the knife is to be drawn as one draws a pencil along a ruler, taking care to sink the instrument to only half the depth of the bone. By this means the strong layer of fascia that runs from the sterno-mastoid to the trapezius is divided. After this—and herein lies the difference in my teaching from that of other operators—no further use of the knife need be made: the structures which lie between the fibrous covering of the posterior triangle and the vessel are so loose and fragile, that they may, as a very general rule, be torn and pushed

¹ A branch from the cephalic vein may run across the line of incision, and be divided; it is sometimes rather large, and bleeds pretty smartly—if so, it should be tied.

² It is not so much the bleeding from this vein that is to be feared, as the possibility that air may enter the lower orifice if it be unwittingly cut across.

aside with the finger; no dissection, such as is prescribed in works on operative surgery, ought to be practised, for it is that which renders the operation difficult, causing hemorrhage, filling the cup-like wound with blood, and obscuring the further steps. The operator, placing his fore-finger in the inner angle of the wound, feels the softer, yielding structures of the side of the neck; further inward, the hard, firm line of the spinal transverse processes covered by the scalenus anticus; and, running outward from the edge of this muscle, the ridges of the brachial nerves, and perhaps the omo-hyoid; still letting his finger course downward along the outer border of the scalenus anticus, he will find its progress stopped by the first rib; when he comes to this point, the artery will be felt beating just behind his finger. If now the head be turned to the opposite shoulder, and the arm of the side under operation be drawn down, the fascia of these parts is rendered tense enough to be easily torn, and with the finger nail, guided by a good sense of touch, the upper and lower margin of the vessel may be cleared. If there be any difficulty, a piece of the fascia may be pinched up in forceps, the absence in it of any vein carefully verified, and a very small rift in it made—from which the tear may be extended with the finger.

Now unless the shoulder be raised by the aneurism, this operation may be performed in a few minutes with the utmost ease; but if that part is pushed upward, very considerable difficulty is produced, for this position may be so embarrassing that the surgeon can hardly orient himself.¹ Furthermore, the clavicle so covers the artery that, even though the aneurism needle may pass beneath the vessel, its handle cannot be depressed; the eye will not go far enough to let the ligature be seized. It is for this object that I devised the needle with the tumbler-end, depicted at p. 926. Unfortunately, I have had no case requiring its use since then; but I have often tried it on the dead subject, while an assistant kept the shoulder well raised, and have found it to answer all expectations.

The above operation is not applicable to *subclavio-axillary aneurism*, but in such cases the *second part* of the subclavian artery is rarely diseased. This fact appears to me to have been somewhat neglected by operators; for in such an event, rather than tie a dilated artery, it will be better to take up the vessel a little further inward, namely, where it lies between the scaleni. Another circumstance which may render this operation preferable to the one just described, may be such a lifting of the clavicle that the third portion of the vessel is inaccessible. The artery lies highest while between the muscles; and the clavicle, raised by an axillary tumor, is less elevated at its proximal part.

Ligation of Second Portion of Subclavian Artery.—To place a ligature on this part of the vessel, a slight modification of the procedure already described is necessary. The skin incision must extend a little more inwards, and the external jugular vein, unless it lie unusually far out, should be tied and divided; the outer fibres of the sterno-mastoid, together with the strong fascia behind it, must be severed. The loose areolar structure overlying the anterior scalene muscle is easily disposed of, and the phrenic nerve as it crosses that muscle very obliquely, must be brought into view. The artery, emerging from between the two scaleni, is now seen; between it and the anterior muscle a curved director is to be passed, and the outer fibres of the latter divided, when the safety of the vessel itself and of its branches has been verified,² and when the

¹ In a case of this sort, on which I operated, my finger sank almost its full length directly downward. I had to verify its position once or twice, the great depth haunting me with a fear that my finger had entered the chest.

² Usually, the only branch given off from this portion of the artery is the superior inter-costal, which is not in the way; but the supra-scapular branch from the thyroid axis is often low enough to be endangered, unless its absence from in front of the part to be incised has been ascertained.

phrenic nerve has been drawn inward or protected. The position of the pleura must also be remembered: its safety can be secured by passing the director, and using the knife, rather on the upper aspect of the artery. The support of muscular fibres causes this part of the vessel frequently to escape dilatation, which may affect both the first and the third part; the condition might be called an hour-glass aneurism. Or disease creeping up along the vessel from the axillary may involve the third part of the subclavian artery, yet terminate sharply and suddenly at the border of the scalenus. In either case, ligation in this situation is far more likely to prove successful than at the third part of the artery.

If the *first part* of the subclavian be also dilated, it may be advisable to extend the incision a little further inward (unless the parts can be drawn in that direction), and to tie also the vertebral; great care must be used to avoid the phrenic nerve. We shall see presently that the very large inosculations at the base of the brain may render it dangerous to keep this vessel pervious.

The statistics of tying the subclavian for axillary aneurism, which will be given immediately, are not very favorable. I am sure that the more modern forms of ligature will change the ratio of cures very considerably. However this may be, it was no doubt these unfavorable results that led Mr. Syme to advise recurrence to the old operation.¹ The case on which he founded his recommendation was one of ruptured artery, and in that instance his procedure was doubtless right, for in such cases the Hunterian method is not likely to prove efficacious.² But no one who reads that surgeon's description of his operation will, I think, be tempted to follow his example in cases of sacculated aneurism, unless the position of the shoulder renders it evidently impossible to reach the subclavian artery. Moreover, in his case, the rupture of the vessel must have been at the lower part of the axillary, since Mr. Syme reached the distal end with ease, and was able to tie the proximal end half an inch *above its orifice*; it is questionable whether a sacculated aneurism of the first part of the axillary could thus be treated, and, even if it were found possible, the mortality would probably be very great.³

Axillary aneurism is a very serious disease, its treatment often proving ineffectual. The failure arises from several causes, viz., (1) the numerous and free anastomoses between the axillary artery and the subclavian; (2) the very loose character of the surrounding structures, causing rapid growth and facile rupture, so that the aneurism, while undergoing treatment, frequently becomes diffused; (3) the fact that the disease, though its symptoms may indicate simply axillary aneurism, often extends above the rib, so that the ligature is applied to a vessel already thinned and dilated—in other words, to an upward prolongation of the sac.

Of statistics concerning this operation, we have a singular abundance in the tables of Norris,⁴ Koch,⁵ and Poland,⁶ the latter, however, chiefly concerning subclavian aneurism, as English and American surgeons define it. Some ambiguity must here arise, since, in different countries, the arbitrary line of demarcation between the subclavian and axillary arteries varies considerably. For English-speaking anatomists, the latter vessel begins at the lower border of the first rib, and for Germans, at the lower border of the pectoralis minor;

¹ Med.-Chir. Trans., vol. xliii. p. 137.

² In a postscript, he mentions having carried out the same method for a sacculated aneurism, the patient returning home in a month.

³ Mr. Syme's proposal to treat inguinal aneurisms and carotid aneurisms on a similar plan certainly cannot be entertained. Treatment by distal ligature will be considered hereafter.

⁴ Contributions to Practical Surgery, p. 220.

⁵ Archiv für klinische Chirurgie, Bd. x. S. 195.

⁶ Guy's Hospital Reports, 1870, 1871, 1872.

while the French take as their boundary "the clavicle," a somewhat movable and uncertain line,¹ and the Italians go still higher, making the subclavian cease at the outer border of the scalenus anticus. This ambiguity I have done my best to eliminate.

Norris gives of deligations for axillary and subclavio-axillary aneurism (I omit operations for other conditions), 60 cases, of which 27 proved fatal—a death-rate of 45 per cent. Koch's tables record 79 cases in which the subclavian artery was ligatured for axillary aneurism,² of which 27 were fatal—a mortality of 34.3 per cent. Since the publication of Koch's paper, which includes, I believe, all the cases noted by Norris, I gather from journals only 11 instances of this deligation, of which no less than 5 died, a mortality of 45.45 per cent. Thus:—

	Cases.	Deaths.	Mortality, per cent.
Norris	60	27	45.
Koch	79	27	34.1
Since 1869	11	5	45.45

. If we put together the two last gatherings,³ we have:—

Cases.	Deaths.	Mortality, per cent.
90	32	35.5

The causes of death in the 32 cases are thus distributed:⁴—

Secondary hemorrhage from site of ligature	10
Suppuration or gangrene of the sac, usually with bleeding	10 ⁵
Rupture of aneurism	1
Gangrene	1
Exhaustion	3
Pyæmia	2
Pulmonary or pleural complications	3
Drunkeness, when nearly well	1
Not stated	1

These numbers seem to me to require still further examination—carrying division still further by separating the aneurisms which were purely axillary from those that encroached on the subclavian—because the larger number of cases which proved fatal from hemorrhage at the site of deligation, and some in which the bleeding came from the sac, were of the latter category; and because, as we might expect, tying the third part of the subclavian when that division of the vessel participates in the disease, is not likely to prove a very successful procedure. Taken, then, in this wise, the statistics stand thus:—

	Cases.	Recoveries.	Deaths.	Mortality, per cent.
Axillary	61	46	15	24.6
Subclavio-axillary	29	12	17	58.6

We may conclude, therefore, that to tie the third part of the subclavian artery, when an aneurism encroaches upward beyond the border of the first rib,

¹ Velpeau (*Anatomie des Régions*, tome i. p. 239) speaks of the lower end of the subclavian as lying on the first digitation of the serratus magnus.

² Among these I include cases of what he terms infra-clavicular subclavian aneurism. My numbers vary from those quoted by Poland, probably from some difference in the mode of analyzing the records.

³ Norris's and Koch's figures, since they include the same cases, cannot be added together.

⁴ Since these statistics were compiled, the essays of my friend, Dr. Wyeth, have been sent to me by their author. I find, at page 239, that he gives 75 cases of axillary aneurism as treated by deligation of the third part of the subclavian; of these 28 terminated fatally, a mortality of 37 per cent.—a conclusion so similar to my own that I have thought it best not to alter my modifications of, and additions to, the figures of Norris, Koch, and Poland, but to leave the two results as corroborative of each other's accuracy.

⁵ Two of these cases had been treated with ergotine injections; the sac was severely inflamed previous to operation.

is a very dangerous though, occasionally, an unavoidable procedure; but that deligation of the third part of the subclavian, when the aneurism can be diagnosed as purely axillary, is comparatively safe, since more than 3 out of 4 thus treated recover.

The cases of axillary aneurism¹ treated in the six London hospitals, the records of which I have utilized, have been 17. Of these, only 4 came to ligature. The smallness of the number is due, I believe, to the effect of Mr. Poland's paper, which brought the operation into a disrepute which, as far at least as purely axillary aneurism is concerned, is undeserved. Of the 4 patients thus treated, 1 died of erysipelas when all but well, and when the tumor was nearly solid. The results of the different forms of treatment employed are here given:—

5, pressure	3 failures, 1 death, 1 recovery.
3, amputation	3 deaths.
1, Valsalva's method and aconite	no benefit.
3, expectant measures, or operation declined	3 deaths.
4, ligature	1 death, 3 recoveries.
1, old operation	recovery.

ANEURISMS OF THE HEAD AND NECK.

Having now traced aneurismal disease of the upper limb to the trunk, we will leave the vessels hitherto dealt with, and will examine the malady as it affects the carotid and its branches.

Aneurism of a *cervical branch* of the carotid may occur, but rather as a surgical curiosity than as a malady requiring notice, save in works especially dedicated to such subjects. In practice, the disease manifests itself either as affecting the main vessel itself (common, external, or, very much more rarely, internal carotid), or as intra-cranial or orbital aneurism.

INTRACRANIAL ANEURISM interests the surgeon but little; it usually manifests itself by death from apoplexy after a certain duration of pressure symptoms, or without such prodromata, and in the post-mortem room by a large effusion of blood in or on the brain, the effusion being traceable to the rupture of some dilated vessel. In a few cases, peculiar signs of localized pressure on the brain, especially if accompanied by complaints of loud whirring or rasping sounds, may lead the physician to suspect the existence of such an aneurism, and this diagnosis is very much strengthened when he can himself hear, by a stethoscope applied to the head, or by the otoscope, some such sound, synchronous with the pulse. It must be remembered that the arteries of the brain are especially those most liable to be the seat of syphilitic degenerations (p. 838), and yet the fact that a patient with symptoms of intra-cranial pressure is syphilitic, may point to the existence of a tumor, gummous or otherwise, as well as to vascular disease. If an aneurism be diagnosed, a certain localization may be sought by finding at which part the bruit is loudest, and by pressure on each carotid alternately, and then on both. Cessation of the noise, on occlusion of one only, might lead to treatment by pressure; but since the vessels which spring from the four channels carrying blood into the skull intercommunicate very freely, any treatment which closes but one of these branches will be likely to influence the condition of the vessels in but a very transitory manner.

¹ Here I have not been able to draw the above distinction.

ORBITAL ANEURISM, or rather *pulsating tumor of the orbit*, presents many problems of great interest and difficulty, for it is by no means to be supposed that the pulsation arises of necessity from diseases of the ophthalmic artery, nor, indeed, that it is in the orbit at all. The maladies which may produce a pulsatile tumor in this situation may be thus classified:—

Within the orbit.	Disease not of vessels. ¹	{	Erectile tumor.
			Myeloid sarcoma, or encephaloid.
	Venous or capillary disease.	{	Meningocele at sphenoidal fissure or at a suture.
			Thrombosis of ophthalmic vein. ²
	Arterial disease.	{	Varicose condition of ophthalmic vein. ²
Aneurism (cirroid) by anastomosis.			
Circumscribed aneurism of the carotid in the cavernous sinus.			
Diffused aneurism.			
			Arterio-venous aneurism.
Within the skull.	Venous morbid condition.	{	Thrombosis of cavernous sinus. ³
			Circumscribed aneurism of internal carotid in cavernous sinus.
	Arterial disease.	{	Diffused aneurism.
			Arterio-venous aneurism.

The diagnosis between the growths first mentioned and vascular disease must be gathered from the general directions given at p. 846; but in this particular situation unusual difficulty is caused by the confined space in which the disease lies, and by the inaccessibility to touch thereby produced. Meningocele of the orbit is very rare, and could hardly occur save in infants, or at least when taking its origin in infancy. The nature of M. Guersant's case, which was brought before the Surgical Society of Paris,⁴ was recognized by none of those who examined it, and treatment with a seton proved rapidly fatal. The presence of a distinct pulsatile tumor, and its being readily emptied by pressure, are the misleading points; but the absence of bruit which can be detected by the surgeon, and of loud noises heard by the patient, should lead to a suspicion of the non-aneurismal nature of the case. If the tumor, not compressing the veins, caused no swollen condition of those vessels, and no marked congestion, the diagnosis would rest between the disease in question and the two other tumors not due to vascular changes; but if such venous disturbance were produced, greater diagnostic difficulties would arise. One of the cases reported was traumatic, the injury occurring at one year of age. The surgeon (Oettingen) examined the case in the thirteenth year of life.

The other divisions of the table relate to various forms of vascular disease, and it will, for the present, be better to consider their symptoms altogether, without further reference just now to their anatomy than the remark that both venous and arterial dilatation are capable of giving rise to a pulsatile tumor of the orbit, and to protrusion of the eyeball (which may itself also pulsate), and this whether the morbid state be located within that cavity or behind it, viz., in the cavernous sinus and surrounding structures. The symp-

¹ To this might have been added certain cases of pulsation which, no cause having been found after death, M. Collard (Gazette Méd. 1866, p. 631) ascribed to a morbid condition of the vaso-motor nerves given off by the lenticular ganglion. Without wishing to deny the possible truth of this causation, I prefer to exclude it from my table as being at present merely speculative, and resting on no fact in morbid anatomy.

² Both of these may result from disease behind the orbit.

³ Solid tumors compressing the cavernous sinus might have the same effect, but in point of fact such have not been found.

⁴ Guersant, *Maladies des Enfants*, p. 246.

toms are these, taken in the order of their usual occurrence: Pains about the orbit, temple, and brow; noise in the head; swelling of eyelids and conjunctiva, with considerable congestion, and, perhaps, a varicose condition of both the palpebral and ocular portions of that membrane; pulsation of the eyeball (sometimes absent); proptosis or exophthalmos, rapidly increasing; more or less rapid disorganization of the globe; formation of a distinct tumor between the eye and margin of the orbit, generally about the junction of the inner and middle thirds of the superciliary arch. In most cases the noise may be heard on auscultation, about the forehead and temporal fossa, or by the otoscope. The exophthalmos has been, in some cases, extreme, the eyeball being quite extruded—in one case it was reported as lying on the cheek below the malar bone. The impairment of vision and the paralysis of orbital muscles is not in strict ratio with the amount of protrusion, being earlier and more marked in certain forms of the disease than in others.

More than half of the recorded cases, viz., 41, have been traumatic. Of these, 31 were in males, 10 in females; 19 were due to falls, 13 to blows about the head, 1 to a blow on the nape of the neck, 7 to wounds (1 charge of shot, 1 splinter of glass, 5 stabs with stick or umbrella). The other cases were idiopathic, namely, 33; of these, 9 only occurred in males, 24 in females. But in nearly all of these, also, the disease commenced suddenly—sometimes after an effort, during the progress of labor, or after a violent fit of coughing—while in other cases the sudden attack began during sleep, without apparent immediate cause. The first advent of the malady has been in such cases marked by a sound, as of a snap, a pistol shot, or the crack of a whip, usually preceded or accompanied by a sense of something having given way within the head.¹ Suggestive of embolism as a possible cause, is the fact that of the idiopathic cases among women, one-third have occurred during pregnancy.

Of the 76 cases on record (three have occurred since Mr. Rivington's paper was published), opportunity for post-mortem examination occurred in only 13. The results were:—

- In 1 case, circumscribed aneurism of the ophthalmic arteries within the orbit.
- “ 1 “ “ “ “ “ “ artery at origin from carotid.
- “ 3 “ rupture of internal carotid in cavernous sinus.
- “ 1 “ atheroma with dilatation of carotid in cavernous sinus.
- “ 3 “ arterio-venous aneurism in cavernous sinus (traumatic).
- “ 2 “ plugging of cavernous sinus and ophthalmic vein.
- “ 2 “ obstruction of blood from orbit in cavernous sinus.

Though we must not accept this table as absolutely representing all the morbid conditions which may produce pulsating tumors, nor their relative frequency—since the more curable forms would escape post-mortem examination—yet we must, to a certain extent, accept its guidance. Now, it is remarkable that we find no case of aneurism by anastomosis, only one case in which the disease was in the orbit itself, and only two of aneurism of the ophthalmic artery. Nevertheless, it is probable that this last condition has occurred more frequently, as in Van Buren's² and Curling's cases.³

The summing up of all the evidence is, that pulsatile tumor of the orbit is usually due to some condition behind that cavity, and as often to venous as to arterial disease; but it appears to me impossible to agree with Mr.

¹ Mr. Rivington's excellent and interesting paper (*Medico-Chirurgical Transactions*, vol. lviii. p. 183) enters minutely into the statistics of this malady, with regard to age, sex, side of affection, etc. For further detail I must refer to that exhaustive paper.

² See paper by Dr. Noyes, *New York Medical Journal*, 1869.

³ *Medico-Chirurgical Transactions*, vol. xxxviii. p. 109.

Erichsen's¹ and M. Collard's view, that the condition may be produced by no disease at all. So obscure, however, are some of the symptoms, that it is at present impossible to fix absolutely the differential diagnosis of certain of the lesions, save by means of exclusion, observation of signs, and inference; yet it is most important, in view of treatment, to be able to distinguish one form of malady—viz., the arterial—from the others.

Circoid aneurism of the orbit is, to say the least, a very rare disease.² Unless slowly supervening upon a badly-healed wound—and that would be a pathological curiosity—it would be the sequela of a congenital condition, and some signs of angeiomatous arteries—not merely varicose veins—would be found. It never could arise suddenly, with a snap or crack, nor follow closely upon some traumatism; nor would the noise be great, but rather a low-breathing murmur than a rasping or sawing sound.

Circumscribed aneurism within the orbit may sometimes exhibit a distinct tumor below the upper eyelid, protruding the conjunctiva, in which case its consistence and mode of pulsation may aid diagnosis; but chiefly must we be guided by its bruit or susurrus. Its clear, intermitting sound can, in typical cases, be hardly mistaken for the pur or snarl of arterio-venous aneurism on the one hand, or for the soft sigh or hum of venous fullness, or of aneurism by anastomosis, on the other.

Arterio-venous aneurism, always traumatic, and usually preceded by signs of fracture at the base of the skull,³ emits a very loud rasping sound, already described.

Venous congestion or occlusion generally comes on more slowly, and is not preceded or accompanied by any smart snap, or sound of breakage; it is marked by complete noiselessness, or very gentle murmur, and by a more compressible, softer state of the tumor, and of the pulsation. The ophthalmoscope may in some cases show particularly well-marked venous congestion, and full vortices, but the instrument is not always available, owing often to rapid changes occurring in the media. Puncture of the tumor with a fine trocar might, as Mr. Rivington suggests, reveal the venous or arterial nature of the contents. The decision as to whether the disease is in the orbit or in the sinus behind it, is frequently impossible, unless fracture of the base of the skull, or certain negative signs about the orbit, be present. Some conclusion may, perhaps, be formed from the different forms of paralysis of the ocular muscles—such symptoms as ptosis, and internal squint from paralysis of the third nerve,⁴ together with slight or no impairment of vision. Again, œdema of the eyelids coming on early, and before pulsation is felt, if its advent be slow, and unmarked either by traumatism or any sudden sense of something giving way, is a sign of venous obstruction; if the heart and large vessels be not markedly diseased, the evidence is in favor of this obstruction being independent either of aneurism or of rupture of the artery in the cavernous sinus. Nevertheless, it must be confessed that many paradoxical cases occur, such as Velpeau's,⁵ in which both eyes were affected, and in which compression of the right carotid stopped pulsation in the left eye, and *vice versa*, a condition which that author and Mr. Holmes have both endeavored, but without success, to explain. Ligature of the right vessel checked pulsation in both eyes for a

¹ Science and Art of Surgery, vol. ii. p. 104.

² Probably Dr. Frothingham's case (American Journal of the Medical Sciences, April, 1876) was of this description.

³ Les anévrismes artério-veineux du sinus caverneux, par M. le docteur Delens. See also Dr. Morton's paper in the American Journal of the Medical Sciences, July, 1870.

⁴ The tumor in the orbit lies, when present, above and inside the eyeball, which is generally pressed outward, so that there is an appearance of external squint, with the eye looking downward; rapid loss of vision is also characteristic of disease within the orbit.

⁵ Delens, op. cit.

time, but this soon recurred in the right eye, while the left was cured. Nor have we the means of diagnosing certain venous conditions of the cavernous sinus from aneurism of that part, nor from similar states in the orbit. Indeed, it is hardly to be perceived whence such means should come; if obstructed veins in that sinus produce pulsation, tumor, exophthalmos, etc., those symptoms will arise, whether the occlusion be produced by aneurism, by rupture of the artery, or by thrombosis of the vein. Hence, operative measures should not too readily be undertaken, since some patients—those of Erichsen¹ and Collard, of Berne,² for instance—recovered; the former nearly, the latter entirely, after merely expectant measures and regulation of diet.

Treatment of Pulsating Orbital Tumors.—The treatment must be guided by the conclusions formed from the symptoms just detailed. I would only point out that compression of the carotid may, in every form of the disease, annul pulsation, even though no aneurism be present; this symptom accompanies the venous turgescence due to thrombosis, the impulse being communicated by the throbbing of the artery.

Expectant and medical treatment is that which is best adapted to cases diagnosed as thrombosis or other affection of the veins. Ice, digitalis, sparse diet, absence of stimulus; in certain cases, iodide and bromide of potassium, with ammonia; purgatives, and if inflammatory mischief be present, means adopted to relieve that condition.

Graduated compression upon the globe and orbit may be useful in the same class of cases. If aneurism be present, it is injurious. Injection of ergot might be employed in cases of any of the diseases mentioned, if its situation within the orbit could be ascertained.

Coagulating injections likewise can only be of use if the orbit itself be the seat of disease.

Galvano-puncture may share the same remark, with this addition, that a strong or prolonged electric current can hardly be conducted through any portion of the head or face without danger.

For all true forms of orbital aneurism, *compression* and *ligature of the common carotid artery* are the remedies *par excellence*; but, as in other parts of the body, deligation of the vessel leading to an aneurism by anastomosis, is rarely curative. For such cases, when recognized, vessels immediately leading to the tumor, such as the facial and the temporal, have been tied, but with only slight and temporary benefit,³ while deligation of the common carotid, after an interval, cured them easily and quickly.

The following table shows the results of the different modes of treatment employed:—

Form of treatment.	No. of cases.	Cured.	Benefited.	Loss of vision.	Unrelieved.	Died.	Subjected to other treatment.
Expectant and medical . .	25	5	1	1	11	7	
Direct compression . . .	10	..	3	..	7		
Galvano-puncture	2	..	..	..	2		
Injection of ergot	2	..	..	..	2		
Coagulating injection . .	4	2	..	1	1		
Compression of carotid . .	16	14	1	1	13		
Ligature of carotid	44	16	6	7	5	6 ^b	4 ^c
Ligature of vessel in orbit	1	1					

¹ Op. cit.

² Gazette Medicale, 1866, p. 321.

³ Warren, loc. cit., first case.

⁴ Rivington gives two idiopathic cases thus treated, as cured, but in one of these vision was lost; in the other noises in the head continued.

^b The cause of death is not stated in one; it was secondary hemorrhage in two; pyæmia in two; cerebral disturbance in one.

^c Three of these were cured: 1 by injection of the lactate of iron, 2 by deligation of the other carotid; 1 died after galvano-puncture.

I have not wished to alter these numbers, gathered from Mr. Rivington's paper, by the addition of the only case published since it was written. This was Von Neiden's¹ case; pressure, continued for ten weeks, failed; ligature of the carotid cured.

Relapse occurred, or threatened, on the other side, in one case; the condition was successfully treated by the administration of digitalis, local compression, and the application of ice.

Relapse on the same side occurred eight times, six of the cases being traumatic; subsidence took place in one idiopathic case, and in two of the traumatic cases. In two American cases, both carotids were tied, and in a third (Frothingham), after partial relapse, the spongy remains of the tumor were dissected out. Since relapse is most frequent in traumatic cases, it is probable that the condition arises from arterio-venous aneurism; or, perhaps, that both carotids, or one carotid and a branch from the other, communicate with the sac of an aneurism behind the orbit.

Ligature in the orbit of an artery feeding an orbital aneurism can only be employed in very exceptional circumstances. The case so treated by Mr. Lansdowne resulted from a wound of the upper eyelid, which was followed by a consecutive traumatic aneurism of the injured vessel.

CAROTID ANEURISM.—Carotid aneurism has been said to be more common in women than in men; but this is an error. I find in Pilz's tables, to be quoted immediately, 88 cases of this disease; of these, 55 were in men and 28 in women, the sex in 5 not being stated. The external branch is affected in 7 per cent. of the cases of carotid aneurism; the internal in about 5.75 per cent. The very large proportion of 87.25 per cent. belongs to the primitive trunk. The most usual point for the appearance of the tumor is the bifurcation, but it may also have its seat quite at the lower part of the neck, immediately above the clavicle. For reasons which will appear shortly, I prefer to divide these cases into those of *high carotid aneurism*, to be now investigated, and of *low carotid aneurism*, which can be better discussed with subclavian, innominate, and aortic aneurisms, under the category of *aneurism at the root of the neck*.

Aneurism of the carotid artery, at or near the bifurcation, lies between the trachea and the sterno-mastoid muscle, and is so easy of diagnosis that nothing on that subject need be said here;² but the surgeon should be aware that a certain normal increase in the size of the artery, just at its division, is, especially in women, not very unusual, and that this expansion may, as age advances, become more conspicuous, either from the loss of subcutaneous fat, frequent in elderly females, or from real enlargement, which may not, however, pass the limits dividing disease from mere peculiarity of form. Hence, a pulsating tumor at this part of the female neck should not be at once considered, still less treated, as aneurismal, more especially if it have been discovered through accident, by touch or sight, or have been merely observed by some third person, the patient experiencing no painful or obstructive symptoms. The rule, in such a case, is to carefully watch the tumor, and to measure it by compasses or other means, from day to day, or week by week. If it be stationary, and no pressure symptoms arise, surgical interference is unnecessary, or may at least be postponed.

CASE XVII.—I was consulted in November, 1878, by Mrs. G., aged 62, on account of a pulsating tumor on the right side of her neck, which gave her no inconvenience, and had first been observed by her husband. There was no history of injury, and the

¹ Zeitschrift für praktisch. Medizin, No. 47.

² Certain points of differential diagnosis between this disease and certain cysts of the neck, are given at p. 845.

lady was in perfect health, but of late had grown considerably thinner. There was very visible pulsation on a level with the thyroid cartilage; at each systole the tumor looked nearly the size of a pigeon's egg; the pulsation, which was markedly expansile, ceased on compressing the carotid below. To the touch, a rather considerable dilatation of the artery was evident, but not as great as it appeared to sight—some of the expansion being certainly venous, probably from pressure of the dilated part of the artery on the jugular vein. I carefully measured the limits of expansile pulsation, and watched the case closely during a fortnight, and in that time found no change whatever. Relaxing my vigilance, I saw the patient then only from time to time. In February, 1879, I happened to meet at her house her younger sister, who told me that previous to her marriage, which happened just before she was twenty, my patient had been very thin, and she (the sister), with others, had often noticed a great beating on the right side of her neck, and that the spot looked then, as far as she could remember, exactly the same as it did at the time of speaking. After marriage, and until lately, the lady had been considerably stouter, and it is likely that the increased *embonpoint* overlay and concealed the pulsation.

While avoiding unnecessary interference, we are to remember that, if the tumor be increasing, no time should be uselessly lost; the growth is in this situation usually rapid; nor is there very much room to spare. Such aneurisms tend, as a very general rule, upward, yet, combined with growth in that direction, a certain downward extension may also occur. If in growing the tumor come to cover the trunk of the artery, the difficulties and dangers of treatment are enormously increased.

Many of the resources of surgery, useful in other situations, are inapplicable to carotid aneurism. Coagulating injections, and even galvano-puncture, would be dangerous in this place.¹ The parenchymatous injection of ergot might be tried by one who had faith in it; and direct pressure by means of a truss-like instrument of a horse-shoe shape—a somewhat modified Signoroni's tourniquet—might be employed if the aneurism were small and firm. But, in truth, our means of attack are almost limited to proximal pressure and ligature.

There is no doubt that indirect pressure, combined or alternated with the direct, may cure a certain class of aneurisms of the neck, as also of the orbit. The compression may be in part instrumental; thus, for instance, a Cole's compressor may be used with the hand. Mechanisms carrying movable arms (adaptations of Carte's instrument to the neck) generally disappoint both surgeon and patient. Digital compression is much more bearable, and, in truth, if a sufficient staff can be mustered, is much more easily effected. The place where the least amount of force exerts the greatest influence, is the carotid (or Chassaignac's) tubercle, as the transverse process of the sixth cervical vertebra is called. Generally, pressure on any part of the vessel produces after a time vertigo, tinnitus aurium, faintness, and a sense of sickness. This is generally attributed to disturbance of the cerebral circulation, but I believe wrongfully. It seems to me that interference by compression with the sympathetic, perhaps also with the pneumogastric nerve, is more likely to be the cause of the unpleasant sensations. After a certain number of sittings the parts become accustomed to the manipulation, and the unpleasant symptoms diminish.

Another mode of compression, that of Rouge, may be substituted for, or may alternate with, that just described; to effect this, the patient's head must be so placed to relax the sterno-mastoid muscle, on one side of which the surgeon places his thumb, on the other his finger; then insinuating them behind the muscle, he, as it were, pinches the carotid between them. The manœuvre is best and most easily carried out some distance above Chassaignac's tubercle;

¹ The gas-bubbles and tar-like fluid, described at p. 865, might act injuriously on the brain.

it fatigues the hand rapidly, but obviates the troubles which patients so often experience when the vessel is compressed against the spine. Even with the best precautions it will be impossible, while the patient is conscious, to prolong the sittings very much, or to let them follow each other rapidly. Thus, in orbital aneurism, the pressure in the three successful cases was used in one case (Gioppi) for a minute or two at a time; in another, for about five minutes; and in the third, from twenty to thirty minutes a day. In the very few cases of success in carotid aneurism, from ten to fifteen minutes' pressure was (if I read the accounts correctly) the utmost that could be borne. The rapid method is, of course, open to the surgeon; but he must remember that this method may require from one to many hours' anæsthesia; he may, during such treatment, have great difficulty in distinguishing between the causes of syncope or asphyxia that may be due either to the direct effect of the anæsthetic, to cutting off a part of the blood-supply to the brain, or to failure of the heart or lungs through pressure upon the pneumogastric and sympathetic nerves. Such pressure, while the patient is under the influence of any anæsthetic, can hardly be free from danger. Pressure is reported to have been successful in six cases; of these, three were traumatic. Of the others, I may say that one occurring in a rather lean old lady (reported as greatly benefited, but afterwards relapsed), was, to my mind, not an aneurism, but one of those not abnormal enlargements at the bifurcation already mentioned. It is quite impossible to ascertain the number of cases in which pressure has been used and failed—and a proportion or percentage of its effects is therefore unobtainable.

The proximal ligature for high carotid aneurism is the form of operation to be chosen, and, when possible, one would elect to tie the vessel shortly below its fork; but in some cases the position of the sac leaves no choice—the vessel must be taken up, if at all, lower down in the neck; the two forms of operation are termed respectively “above” and “below” the omo-hyoid. The former is the easier, and is thus performed.

Ligation of Carotid above Omo-hyoid.—The patient, being etherized, should have a rather thick pillow placed under the shoulders, but none under the head, which, falling back, renders the middle part of the neck prominent; the face should be slightly turned towards the unaffected side.¹ The surgeon feels about midway between the clavicle and the ear for the edge of the sterno-mastoid muscle, and makes there an incision about two and one-half inches long, so placed that its middle shall be on a level with the cricoid cartilage. This incision may go at once through the platysma and fascia, but if this latter structure be not then divided (the muscular fibres of the sterno-mastoid not being in view) the knife must be drawn down the track again. In doing this, it is well to spare any large vein (the external jugular sometimes crosses here), or to tie it, if divided, at both ends. The operator's finger will, if the fascia have been sufficiently incised, very easily turn the sterno-mastoid outward, and then will be seen the omo-hyoid, which can generally be pressed inward without using the knife; or the fascia, on its outer edge, may require some dissection. These two muscles, with the other soft parts, are now to be held respectively inward and outward. On looking into the wound, the operator sees the yellow, fat-charged fascia, one

¹ Once or twice I have found my assistants forcing the patient's chin far over to the opposite shoulder; this embarrasses, as it causes the sterno-mastoid to overlie the artery: the chin should be kept about midway between the acromion and the episternal notch of the opposite side. I may add here, that in certain aneurismal cases (aortic and innominate) the etherized patient cannot breathe while the head is thrown back; the anæsthetizer is obliged to insist on bending it forward, and the operator has to get at the vessel under very trying circumstances, since in that posture it lies much deeper, and the ramus of the jaw is terribly in the way.

part of which covers the vessel (sheath), and, running obliquely through it, a quantity of veins, which should be avoided¹ by placing the finger in the depth of the wound, and finding the pulse of the carotid at a place free from venous complication. Here a bit of the fascial sheath should be pinched up on the front, inner aspect of the vessel, a little hole made, the director passed in, the safety of the descendens noni nerve verified, the sheath slit far enough to let the naked artery be seen, and the needle passed from without inward.

A few words about the nerves. The descendens noni lies at this place, on the outer aspect of the sheath, and will rarely be endangered if that structure be opened as above described; but it is well to see that it is out of the line taken by the director; if its absence there be verified, it need not be hunted up elsewhere. The pneumogastric nerve lies in the interval between the artery and vein in the back part of, but not loose in, the sheath; each of the vessels, as well as the nerve, has a compartment, strongly walled, to itself, while the sympathetic, behind the sheath, is also separated by a thick fascia from the vessels. If these anatomical positions be maintained, both nerves are safe.² Young operators are sometimes made anxious and embarrassed by unnecessary cautions, yet sometimes the parts do not quite maintain their proper positions; hence it is well, before tightening the ligature, to see that it includes the artery only.

Ligation of Carotid below Omo-hyoid.—The low operation also requires an incision about two and a half or three inches in length, along the inner margin of the sterno-mastoid; it may extend from just below the level of the cricoid cartilage to an inch or half an inch above the sterno-clavicular joint.³ The fascia may be freely divided and the muscle turned outward; judging from my own experience, it can very rarely be necessary to sever its sternal origin. When this has been done, much caution in the use of the knife is advisable. Many veins, much engorged if there be dyspnœa (sometimes the anterior jugular lies here), meander in this space; they and the loose fascia can generally be pushed away with the finger until the omo-hyoid is seen. Along the inner border of this muscle, as it lies on the sterno-hyoid, a few touches of the knife are required in order to allow of its being drawn upward and outward; the finger and a blunt hook will now turn and hold the outer edge of the sterno-hyoid inwards. The sheath, avoiding the descendens noni, is to be opened and the ligature passed as in the higher operation.⁴ The unaccustomed operator should be prepared for having to go very deep, especially on the left side, where the vessel seems almost to lie in a pit.

After deligation of the vessel, the size of the aneurism may not much decrease, and pulsation, although arrested, may return after a very short time. This results chiefly from the very free communication of the vessels of the two sides at the base of the brain. Blood finds its way through the circle of Willis into the internal carotid of the affected side, and to that part of the common trunk which lies above the ligature, thence into the external carotid,

¹ I have generally seen here a very full, turgid vein, the superior thyroid, coming obliquely from the larynx to the internal jugular; it sometimes runs before, more often behind, the carotid. I suppose it is the effect of the anæsthetic, which causes this to swell to the size of a cedar pencil.

² Pilz (Zur Ligatur der Art. carot. comm., *Langenbeck's Archiv*, Bd. ix. S. 399) says that the vagus has probably never been included in the ligature, but that a piece has been cut out of it; but that, on the other hand, the sympathetic nerve has been tied with the vessel. Neither of the cases to which he refers, was one of simple deligation—the former extirpation of a tumor, the latter a complicated deligation of several arteries for secondary hemorrhage.

³ The length of the patient's neck and the position of the aneurism cause some slight variation in placing the incision.

⁴ It is well to say that, in operating on the right side, more especially if a ligature which divides the inner vascular coats be used, the artery should not be attacked too low. The only case of fatal secondary hemorrhage which I have ever had in this operation, followed the ligation of a carotid with catgut close above the sterno-clavicular joint.

and so to the face and parts outside the skull. The operation, however, having relieved the blood-pressure, and the current being very indirect, coagulation, though slower than in arteries whose branches anastomose by less patent communication, nevertheless takes place. The nearer to the bifurcation is the opening between sac and artery, the slower *ceteris paribus* is solidification. I use the words "other things equal," because a large aneurism with a small mouth consolidates more quickly than a small one with a large orifice.

Before going on to study the mortality of tying the common carotid artery, it is necessary to consider its effects upon the brain. On this subject we have a variety of tables, which vary considerably; I will place their results in their chronological order:—

	Whole number of cases.	Cases attended with cerebral complications.	Per cent.
Norris ¹	138	30	21.
Ehrmann ²	213	47	22.
Pilz ³	482	154	32.
Lefort ⁴	241	73	30.
Wyeth ⁵	789	53	6.7

The death-rate of those affected with such symptoms varies, in these several authorities, from 56 to 73 per cent.

When we consider the marvellous freedom of circulation in the brain, and remember that its tissue must be saturated with nutritious fluid always migrating from the vessels, quite sufficient to last until the momentary local anæmia has passed away; and when we reflect that in consequence of hemorrhage at distant parts, or from other cause, complete syncope and coma often must render the brain all but bloodless for lengthened periods without permanent ill results, it is, I submit, impossible to attribute these alleged cerebral effects to the obstruction of one only out of four large streams that supply the organ. This view is greatly corroborated by certain cases in which, one carotid being already plugged, the other has been tied; and still more by 29 cases recorded by Pilz, in which one carotid was tied a certain time after that on the other side had been ligatured. Of these patients 8 died, 21 recovered. Among the fatal cases is one (Longmore) of gunshot injury, which appears to have been, rather than the operation, the immediate cause of death. Cerebral disturbance occurred in but five of these cases. Wyeth records 33 cases in which both carotids were tied at intervals varying from three days to six years (in one case of gunshot injury both vessels were tied simultaneously). Of these cases 9 only died, five of the deaths occurring in cases of gunshot wound and hemorrhage, and the fatal result being due to the injury rather than to the operation. So low a death-rate shows that cerebral anæmia can hardly be produced by tying a single carotid. The same thing is shown by the case of Dr. Smyth, who, 54 days after tying the right carotid, ligatured the vertebral on the same side; yet no brain symptoms were observed. Rossi, too, tied the right carotid of a patient who after death was found to have the left carotid and right vertebral obliterated; during the six days of his survival, the brain was nourished through the left vertebral alone. In no instance of tying the innominate, which operation cuts off all the right blood-supply of the brain, have cerebral symptoms been observed. We must, therefore, seek some other cause for the large percentage of brain complications ascribed by some authors to carotid deligation. I believe it may be

¹ I exclude the distal method and deligations undertaken for the cure of cerebral affections.

² Des effets produits sur l'encéphale par l'oblitération des vaisseaux qui s'y distribuent. Paris, 1860.

³ Archiv für klinische Chirurgie, Bd. ix. S. 257.

⁴ Gazette Hebdomadaire, 1864 and 1868.

⁵ Essays in Surgical Anatomy and Surgery, p. 120. This author speaks of delirium, convulsions, and other slight cerebral symptoms as occurring in 18 other cases.

accepted that a very large majority of the cases in which so-called cerebral symptoms have supervened from the seventh to the tenth day, or later, were cases of pyæmia—a malady which twenty-five or thirty years ago was but little understood. Some of the deaths may have been due to detachment of minute portions of clot. Pilz infers from the small number of deaths when both carotids have been tied, that the brain trouble, when one only is ligatured, may be due to a want of balance in the circulation. However this may be, it cannot be denied that deligation of one carotid is sometimes followed by cerebral disturbance, a fact whereon Le Fort founded his recommendation to tie, whenever possible, the external rather than the common carotid. No doubt this advice is in accordance with those sound surgical principles which would forbid a large operation when a smaller one would suffice, and a possible complication, however remote, might be avoided. Dr. Wyeth¹ has, of late, even more strongly emphasized this view, and has supported it by numbers, finding that the death-rate of tying the external carotid is only four and a half per cent. It must, however, be pointed out that cases of aneurism suitable for this deligation must be very rare: in 91 cases of this procedure, aneurism (described as being in the parotid) is given but once as the cause of operation.

The statistics of carotid deligation for aneurism, have been collated by Norris (38 cases), Pilz (86 cases), and Wyeth (106 cases); but, for the purpose in hand, none of these collections can be accepted without some examination and sifting of the materials, since many of the cases belong to a category already studied as orbital aneurism, or to that of cirroid aneurism; and since some of them are examples of mistaken diagnosis. We will take carotid aneurism, properly recognized, excluding all other cases; nor will it be necessary to refer more particularly here² to the work of older compilers, since their tables are included in the more modern record of Dr. Wyeth.³ I have separated examples of aneurism from the rest, and have added one or two other cases. Thus are collated of deligations of the common carotid artery for aneurism of that vessel, or of a branch (exclusive of orbital or intra-cranial disease), cases, 107; recoveries, 77, or 71.96 per cent.; deaths, 27, or 25.23 per cent.; deaths from independent causes, 3, or 2.8 per cent.⁴

The causes of death may be stated thus:—

Hemorrhage	{ place not mentioned	.	.	.	.	.	.	.	6
	{ from sac	.	.	.	.	.	.	.	2
	{ from site of ligature	.	.	.	.	.	.	.	1
Inflammation, suppuration, or rupture of sac	.	.	.	.	.	.	.	.	4
Exhaustion	.	.	.	.	.	.	.	.	1
Pyæmia	.	.	.	.	.	.	.	.	2
Inflammation of lung	.	.	.	.	.	.	.	.	1
Cerebral complications	.	.	.	.	.	.	.	.	8
Not stated ⁵	.	.	.	.	.	.	.	.	4

¹ Op. cit., p. 132.

² Subtracting 8 of the cases given by Pilz, we have 78, of which 55 ended in cure and 23 in death; of these deaths, 2 are unrelated to either the aneurism or the operation (causes, cancer of rectum, and general atheroma). Thus the true life-rate and death-rate in the 78 cases are as follows: Recovered, 55, or 70.5 per cent.; died, 21, or 27 per cent.; died from independent causes, 2, or 2.5 per cent.

³ Dr. Wyeth's collection of operations amounts to the astonishing number of 789. It is, I think, to be regretted that his table is arranged only according to the alphabetical sequence of the operator's names. Form of disease or injury, mistaken diagnosis, and chronology, are thus neglected, and the cases, being lumped together, require much sifting and examination previous to being used. Of his 789 cases, 328, or 41 per cent., proved fatal, a ratio much too high for aneurisms, and much too low for gunshot or other severe injuries.

⁴ These numbers include eight distal deligations for carotid aneurism, but none for innominate or aortic aneurism.

⁵ The number of deaths appears greater than that given above, because two cases appear under headings of both hemorrhage from sac and rupture of sac. Pilz records 12 deaths from hemorrhage, viz., 9 from the sac, 1 from point of ligature, 2 site not stated.

In considering the deaths from hemorrhage, we must distinguish clearly between those bleedings which spring from the site of deligation and those which arise from the sac. It is a pity that this distinction is not made in Wyeth's table. But I have been able to procure fuller information in many cases. Thus, in all the 107 deligations for carotid aneurism, bleeding occurred but twice from the site of ligature alone, and once from that place and from the sac simultaneously. This distinction is important, because, in a certain proportion of cases which must stand on the fatal side of the list, the operation affected the result neither one way nor the other: the sac continued to grow, and ultimately burst, just as though no operation had been performed. It appears, then, that we may accept a little over 25 per cent. as having been the mortality of this operation up to the present time, but it is probable that the immediate future will diminish this proportion very considerably.

The *old operation* for carotid aneurism was advocated by Mr. Syme as even the best primary procedure; but the vessel is badly placed anatomically, since it is difficult or impossible to command the circulation; and any surgeon who reads the account which Mr. Syme gives of his operation (a traumatic case), will hardly be induced to follow that eminent surgeon's example. If, however, the Hunterian operation have failed, and the aneurism continue to increase, the old method may be practised with comparative facility, since the ligature obstructs the artery sufficiently to make it safe. This has been done twice in America, and quite lately in London, by Mr. Morris.¹ No difficulty was experienced in the operation.

ANEURISM OF THE VERTEBRAL ARTERY.—This is always traumatic, following punctured wounds (stabs) at the side or back of the neck, or more rarely bullet-wounds. No instance of spontaneous aneurism has been, as far as I know, recorded. Although rare, 22 wounds and aneurisms of the vertebral artery have been collected.² The usual place of injury is between the first and second vertebræ, where the vessel makes its turn to pass outwards to the foramen in the wider transverse processes of the former bone; but in two cases it was between the second and third vertebræ; in one between the fourth and fifth; and in one (Koehler's) between the fifth and sixth.

Of great surgical interest is the diagnosis of these cases, the difficulties of which will be at once apparent when it is stated that, in more than half of the recorded cases, viz., in 12, the disease was mistaken for aneurism of some branch of the carotid; and that in 11 cases that vessel was tied, while in one the inferior thyroid was supposed to be the wounded vessel (Maison-neuve), and tied first; but afterwards, since bleeding did not cease, the vertebral also was ligatured.

The *situation* of the wound helps but little in the diagnosis; in most cases this has been near the skull, and about an inch behind the mastoid process; hence the surgeon is very likely to attribute the bleeding or the aneurism to the occipital artery, or, if the injury be lower, to the ascending cervical. In certain other cases, the penetrating wound has passed through quite different parts, namely, "mouth" (twice), "cheek," at "the angle of the jaw," "under the ear," etc., where certainly a branch of the carotid would appear to be more exposed to injury than the vertebral. Since, then, situation of the wound gives no certain indication, the only method is to observe whether

¹ Medico-Chirurgical Transactions, vol. lxiv. p. 1.

² Sixteen have been gathered by Barbieri, of Milan; four are mentioned by Pilz; and the other two are the cases of Lücke (Langenbeck's Archiv, Bd. viii. S. 78) and of Koehler (Ibid., Bd. xii. S. 867).

pulsation ceases—or, in cases of wound, whether hemorrhage is arrested—by pressing on the carotid; but it is just this pressure, exercised in the usual way, but with insufficient consideration of its effect, that has so completely misled diagnosis in the large number of cases above referred to.

The place usually chosen for compression of the carotid artery is the transverse process of the sixth cervical vertebra, or perhaps, since the skin and fascia tend to bear the finger upward, a little below this point. Now this pressure, properly carried out, will certainly check all pulsation in the carotid and its branches, or in their aneurisms; but surgeons, founding upon this fact a diagnosis of carotid aneurism, have been led into grievous error, because they have not remembered that such compression must infallibly affect the vertebral also. Even if the carotid be compressed against a transverse process higher up, there yet will remain a source of error in the irregularity of the vertebral, which occasionally does not pass into the chain of foramina until it reaches the axis. Hence the only means of secure diagnosis is by pinching the vessel, after Rouge's method (p. 947), with the finger and thumb behind the relaxed sterno-mastoid, while the soft parts are drawn a little forward—away, therefore, from the spine, and not pressed against it. By this means, doubtless, an accurate diagnosis may be arrived at.

Treatment of Vertebral Aneurism.—The treatment of these cases has not been fortunate; indeed, only two—those of Möbus¹ and Kocher—have ended favorably. This infelicitous result is doubtless in part owing to mistakes of diagnosis, but also to inherent difficulties in the anatomical arrangement of the parts, which is such as to preclude the use of many of the means usually at our command. Pressure on the lower end of the vertebral could certainly not be borne without an anæsthetic long enough to have any effect on a traumatic aneurism; nor do I think, seeing how free is the intercommunication of vessels at the base of the brain, that the prospects of a good result would be sufficient to warrant an attempt to cure by proximal pressure after the rapid method. The *injection* into the sac of perchloride of iron could not be effected under the principles necessary for success, namely, occlusion of the vessel, at least on one side of the aneurismal sac; while the danger of the clots and the solution being carried into the brain, is very evident.² The same may be said of *galvano-puncture*, though that might be more safely used, since the clots formed by the current are less persistent. The *parenchymatous injection of ergotin*, unless the rapidly growing sac demanded the immediate use of more potent measures, might certainly be tried. Probably, however, in most cases, carefully applied direct pressure and the application of cold will be found the most efficacious of all the non-operative measures.

As already said, only two cases have ended well, the first being that of Möbus—a traumatic aneurism which was judged to be formed on a branch of the carotid; the vessel was exposed, and the aneurism needle passed round it, when pressure on the curve of the instrument being found not to restrain pulsation, the wound was closed. The patient refused to submit to further operation, and under the application of cold the aneurism consolidated.

The successful case of Kocher was one of stab on a level with the interval between the fifth and sixth cervical vertebræ. The wound had been received three weeks previously, giving rise almost daily to hemorrhages, which had been treated with pressure and the application of pads steeped in the liquor ferri perchloridi. Kocher introduced his finger, enlarging the wound pretty freely, and removing laminated, discolored, and loose, dark clots. He then

¹ Gräfe and Walther's Journal, Bd. xiv.

² The only case thus treated (Lücke) died with brain troubles, repeated injections having probably much to do with the result.

found that by pressing from above on the sixth, or from below on the fifth, transverse process, hemorrhage was arrested. He could even seize the bleeding point with long forceps, but it was impossible to tie any vessel, "as the ligature had nothing to grip." He therefore introduced a pad, the size of a pea, steeped in perchloride of iron, upon the bleeding spot and well between the transverse processes. Most fortunately this device succeeded, and the patient recovered without further trouble.

The case is thus shortly related to show what difficulties the surgeon who should attack such a case by the old (Antyllian) operation might have to encounter, for the aneurism is partly situate between the bones, and nothing would be found that could be tied.¹ A firm plug of lint, as in the above case, might prove successful, but the inference to be drawn is rather to avoid operation, unless it be actually forced upon the surgeon.

The device proposed by Gherini to lay bare the transverse processes above and below, sufficiently to permit the passage of an armed needle inside the course of the vessel, over and below its wound, is fraught with difficulty and some uncertainty, but in case the plug did not fulfil its object, the method might be tried in spite of the danger of wounding a nerve trunk as it passed from the spine. Were all these methods to prove ineffectual, a last resource, one almost of despair, would be to tie the vertebral both below the sixth and below the first vertebra.²

ANEURISMS AT THE ROOT OF THE NECK.

In tracing the carotid vessel lower down, we come to the *root of the neck*, a region in which several forms of aneurismal tumor may show themselves. It appears to me, therefore, advisable to class all these aneurisms together under one general title, as thereby we shall avoid unnecessary repetition or wearisome reference. Under this head are included *low carotid*, *subclavian*, and *innominate* aneurisms, as also those *aortic* aneurisms which, springing from the first or second part of the arch, make their appearance above the sternum or clavicles, and always affect the upper two or three intercostal spaces of the chest. By this arrangement it is not intended to lump or confuse together these different forms of disease, but rather by comparing them to draw distinctions, more closely contrasted. We have, then, many forms of the disease to study here: two involving the subclavian (1st and 3d parts); one, the lower part of the carotid; two, the innominate (high and low); and several forms of aortic aneurism,³ all liable to make their appearance within a very limited space.

ANEURISM OF THE THIRD PART OF THE SUBCLAVIAN ARTERY.—This frequently manifests itself by very severe, neuralgia-like pains, running from above the collar bone down the arm, and to the back of the shoulder, before any distinct swelling is noticed; indeed, I have seen two cases in which such distressing pains, lasting for two months, had almost worn out the patient before aneurism was detected.⁴ When enlargement becomes perceptible, it

¹ An authority on aneurism, writing in the *Lancet*, proposes this operation in vertebral aneurism; but as is seen from the result of treatment when the disease is about the tarsus (p.903), the method is hardly applicable when the sac and its vessel are inclosed in bones.

² In the dead subject it is quite possible to tie the vessel as it makes its turn between the axis and the atlas.

³ I shall presently have occasion to point out the essential differences between aneurism of the ascending aorta and of the proximal and distal portions of the transverse aorta.

⁴ Nevertheless, this symptom is by no means conclusive. In 1878, a gentleman avoided a fall at a fence by hanging forcibly to a hurdle stake; pains, such as described in the text, super-

first shows itself above the middle, or rather a little outside the middle, of the clavicle; frequently that bone is very early in the case pushed forward, and soon beats with a communicated pulsation; especially is this the case in feeble persons and in women. When the shoulder begins to rise, one may see the throb in the little triangle bounded above by the clavicle, at the sides by the deltoid and greater pectoral. In all cases, the pulsation is strong, while the radial pulse on the diseased side is weakened. The aneurism, unless it encroaches on the proximal part of the vessel, never pulsates in the episternal notch; venous congestion of the arm only comes on when the tumor is large; congestion of the face and neck is absent.

The disease is peculiarly liable to begin about the lower margin of the first rib, and to spread thence either downward, when it becomes high axillary aneurism, or upward, when it comes under the category of pure subclavian aneurism; not infrequently it spreads in both directions; it is then subclavio-axillary. The extension upwards is, as a rule, checked by the scaleni, which, supporting the vessel on all sides, prevent dilatation; but in some cases, those, namely, in which atheroma extensively affects the whole arterial system, the second part may be involved with the first, or with the third; or, indeed, the whole vessel, from beginning to end, may be affected generally by dilatation (fusiform aneurism). In such cases, the tumor is very generally constricted where it passes between the scaleni, so as to assume an hour-glass form. Aneurism never, I believe, begins in the second part of the vessel.

The pressure symptoms vary somewhat according to the size of the tumor, its exact place on the vessel, and the direction of its growth; thus, while pressure merely implicates the nerves of the arm and shoulder, with slight enlargement of veins—chiefly those about the acromion and the external jugular—we have to do with an aneurism of only the third part, or encroaching but slightly on the second; but more marked venous congestion, especially if it implicate only the arm and hand, points to extension of disease towards the axilla. If, on the contrary, the face and neck—the whole jugular venous system—becomes engorged, the disease is intruding inwards towards the first part of the artery; and this diagnosis is greatly strengthened if some loss or diminished resonance of voice, and a certain teasing, irregular, laryngeal cough, be observed.

The third part of the subclavian artery is aneurismal about six times as often as the first part,¹ and is three and a half times more common on the right side than on the left, and about ten times more frequent among men than among women. In about one-eleventh of all the cases of subclavian aneurism, the first part alone of the vessel (on the right side) is involved, and even of this proportion the immunity of the rest of the artery is in a certain fraction doubtful. The first part of the left subclavian artery develops aneurism (unless merely as forming part of aortic disease) very exceptionally.

ANEURISM OF FIRST PART OF SUBCLAVIAN ARTERY.—An aneurism of the first part of the right subclavian shows itself by a tumor, which generally appears under the clavicular part of the sterno-mastoid muscle; it lies, therefore, a little outside the place where carotid aneurism first appears. The shape

vened, and gradually increased, for four months; after that time he came to me, and, on examination, I found the subclavian artery, which lay high, beating violently. The space, however, was puffy, and swollen beyond the limit of pulsation; the artery appeared to me flattened rather than dilated; but in a case of such difficulty and importance I conceived it my duty to ask for a consultation. Sir J. Paget, examining the case with me, confirmed my view of its non-aneurismal nature, and expressed the opinion that neuritis of the brachial plexus produced the pains and pressed the artery forward. Under treatment founded on this diagnosis, and on the gouty habit of the patient, he slowly recovered.

¹ I include subclavio-axillary aneurism in this computation.

of the swelling is a rather elongated oval, the long axis oblique, the lower part of the tumor being covered by the clavicle; it may, indeed, protrude and pulsate also just below that bone. If the shoulder be raised, this bone glides over the tumor until the whole of a moderately small, or only part of a larger aneurism, is thereby concealed. If large, an aneurism in this situation may press the clavicle forward until subluxated.

Certain pressure-symptoms are well marked. The first is usually a teasing cough, with altered voice, from slight stretching of the recurrent laryngeal nerve; then the internal jugular vein becomes distended, and may be seen engorged at the lower part of the neck. The tributary veins are also full; this is especially the case with the external jugular, which, assuming part of the deeper vessel's office, becomes often exceedingly large. At a somewhat later period the veins of the hand and arm swell, and then those of the front wall of the axilla.

As the tumor increases in size, so are these symptoms aggravated. Irritation of the larynx yields to paralysis of the vocal cords; the veins of the neck, arm, and side become fuller, and these parts may even become varicose; the radial pulse is weaker than on the other side, and, indeed, is sometimes barely or even not at all perceptible.

There is frequently some difficulty in distinguishing low-carotid, subclavian (of first part), innominate, and even, strange as it may seem, certain aortic aneurisms, from each other. Diagnostic signs are chiefly derivable from comparison of the radial and carotid pulses on the same side. If the innominate be unaffected, the beat of the carotid is not altered; hence a pulsating tumor above the clavicle which greatly affects the radial, but not at all the carotid pulse, is purely subclavian; the innominate is involved if the impulse of both vessels be modified. Moreover, a purely subclavian aneurism is hardly ever to be felt in the episternal notch; while innominate and proximal aneurisms of the aortic arch can very nearly always be detected in that situation.

Carotid and subclavian (first part) aneurisms of the left side are more easily differentiated, the absence of an innominate rendering them independent of each other. The first part of the carotid—namely, that between its origin and the sterno-clavicular joint—is only the subject of aneurism as forming part of aortic disease. The same may be said of the intra-thoracic portion of the subclavian. It need hardly be said that in subclavian aneurism of the left side, laryngeal symptoms are absent.

LOW CAROTID ANEURISM.—The tumor, while yet small, is felt to beat in the angle between the sternal and clavicular portions of the sterno-mastoid muscle; and when that muscle is relaxed, so that the finger can be passed behind its inner portion, the rounded margin of the pulsating swelling can there be distinctly made out. As the size of the aneurism increases, its inner edge comes to lie inside this muscle, and may be felt in the right¹ portion of the episternal notch. The tumor, if ovoid in shape, has its long axis directed upward and downward. The impulse is upward. I do not, of course, mean that the blood-stream can actually be felt, but that the expansile wave is in that direction. The pulse of the carotid above the aneurism, about on a level with the thyroid cartilage (where it is most easily felt), is decidedly weaker than on the left side, as is also the beat of the arterial branches—the facial on the lower jaw, and the temporal; I rely rather upon the extremely facile compressibility of the arteries than on their mere weak beat. This peculiarity is carried even into very small branches, for if the patient's ears be nipped simultaneously and with equal pressure for a few seconds, between the finger

¹ The aneurism is supposed to be of the right carotid.

and thumb of each hand, and then suddenly released, the white mark thus produced will regain its color more slowly on the diseased than on the normal side. These signs show that the carotid artery is aneurismal.¹ We now must discover if it alone be involved. The "exclusion signs," as they may be called, are these:—

There is no sign of pressure on any vein, nor, unless the tumor be very large, on any nerve; larynx, trachea, and œsophagus are all unaffected. Until the sac is large enough to press on those tubes, the radial pulses are alike and unaltered; percussion-sounds of the parts below the sterno-clavicular joint are normal; unless of course the lung happen to be diseased, there is no dullness over the first rib and intercostal space.

It is assumed in the above paragraphs that the aneurismal nature of the tumor has been distinctly verified; nevertheless, I would point out that it is well to give the patient a little water, and while he is swallowing to watch the behavior of the tumor—if it rise with the trachea or remain stationary. It is well to point out that the lower, like the upper, part of the common carotid, is in women occasionally the subject of a peculiar condition, which although anatomically abnormal, is yet not the result of disease. I have never had the opportunity of investigating this peculiarity after death, but, from study during life, the condition appears to be the result of the mode in which the innominate divides, incorrectly represented in anatomical works. The received idea of this bifurcation is, that the two vessels arise side by side from the end of the parent stem—in reality they spring one posterior to the other, the subclavian behind. Now, in most persons, the carotid runs straight from this point to its bifurcation, leaving a little space, the thickness of the clavicle, between itself and the sterno-mastoid, just above that bone; but in other persons the vessel bends forward over the upper border of the clavicle, touches—even flattens itself a little—against the fascia between the two parts of the muscle, and then swerves back again. The most prominent part of this curve pulsates visibly, sometimes strongly. The sense of touch will, however, distinguish this beat of a perhaps slightly dilated artery, from that of aneurism.

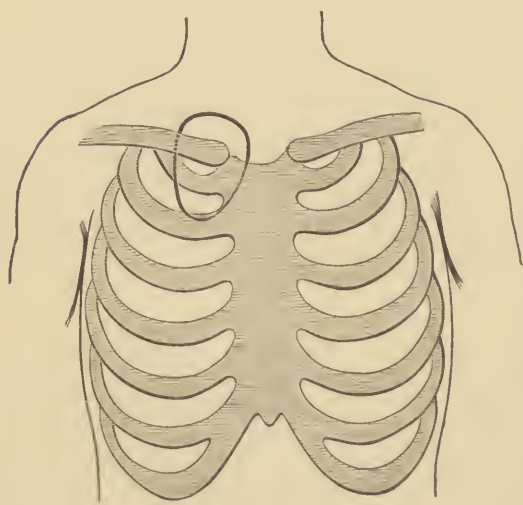
INNOMINATE ANEURISM, pure and simple, is not a common disease, the trunk being so short that either one or both of its branches, or its root on the aorta, are involved, either at first or soon after the commencement of the disease. Indeed, clinical experience convinces me that many cases of innominate aneurism begin at one or other end of the vessel. Thus, as with carotid aneurism, we encounter a high and a low form of the disease, the symptoms of which are different. Nay, more, the high form, which term indicates participation, perhaps commencement, of the disease in one or other derivative, exhibits different symptoms, according as it begins on the carotid or on the subclavian aspect of the vessel. These differences chiefly regard the results of pressure. Some ambiguity may, however, be produced by a form of aneurism, purely aortic, which, springing from the front of the arch, near the root of the brachio-cephalic trunk, expands in front and in the direction of the latter vessel, occupying anatomically very much the same place as the disease under consideration.

The tumor of an innominate aneurism generally occupies the episternal notch, but chiefly on the right side, and, even though it may not rise high, takes up the whole breadth of this space. On gently pressing the finger backward and downward, the rounded margin of the sac can be felt. After

¹ It is true that some other forms of aneurism may compress the lower end of the carotid, and obscure the symptoms; these forms are detected by the signs now to be specified.

a little time, the sternal end of the clavicle protrudes abnormally and partakes in the pulsation (communicated), while the sternal and afterwards the clavicular portion of the sterno-mastoid is also pushed forward. Not unfrequently the first costal cartilage, outside where it joins the sternum, is also abnormally prominent, and throbs with the beat of the tumor. These parts are dull on percussion; there is a peculiarity in the dullness of aneurism, which should be observed, namely, that in the centre it is complete, but at the circumference, on each side, incomplete or relative, gradually, as we go outwards, merging into the clear percussion note. Downward, the want of resonance usually mingles with the normal, aortic, and further downward and to the left, with the cardiac dullness. But occasionally, especially if some dyspnoea exist, a significant, resonant space lies over the sternum, between the second costal cartilages, dividing the cardiac from the tumor dullness. Its appreciation depends on the mode of percussion; gentle taps elicit hyper-resonance; heavier blows the deeper dullness. This condition is produced by an emphysematous lung-margin, overlying the commencement of the aorta. The pulsation is most marked where dullness is most complete, but extends even into the limits of relative dullness. Occasionally, a pretty evident throb may be felt beyond the dull

Fig. 547.



Area of pulsation in early innominate aneurism.

region. The area of pulsation, until the tumor is large, may be taken as in the annexed diagram. The stethoscope detects over all this space the heart-sounds, with exaggerated distinctness; but they are altered in a way that has been insufficiently, if at all, pointed out, viz., while both are heard as plainly as, perhaps even more plainly than, over the cardiac space itself, it is the second sound which is more especially exaggerated, and this is often louder than the first; the thinner the wall of the aneurism, and the freer from any lining of blood-clot, the more predominant is this second heart-sound. The pulses of the right radial, and of the carotid and its branches, are altered, weak, and compressible.

These signs are such as we meet with in the form of disease which affects the upper part of the trunk, and either commences in or tends to carotid complication. But cases occur in which the tumor lies more outward in the episternal notch, and in which it may be felt along a certain distance of the clavicle, the symptoms being those of innominate and subclavian aneurism combined.

The pressure symptoms of innominate aneurism are very variable: sometimes slight, sometimes remarkably severe. If the *high form* of the disease be on the inner aspect of the artery, there is at first a constant, teasing cough; this afterwards gives place, as the tumor grows, to dyspnoea, with paroxysms of coughing and breathlessness that seem about to prove fatal, until relieved by discharge of mucus or muco-pus. No venous pressure is demonstrable until the disease has attained considerable dimensions. When the tumor lies

outside the episternal notch, there is at first an abnormal voice, tending to break into falsetto, afterwards want of tone, and then aphonia, with a tendency to "swallow the wrong way;" and about this time congestion of the left arm and of the left side of the head and neck. There is no dyspnœa until the tumor has become large.

The *low form of innominate aneurism*, as it is usually combined with aortic disease, must be considered with that subject hereafter; but it will be well to point out here some remarkable peculiarities in the pressure symptoms. There are respiratory complications—paroxysmal metallic cough without aphonia, and marked dyspnœa. But the point to be especially remarked is this: the pulsation, dullness, abnormally loud heart-sound, etc., are on and to the *right* of the middle line; the venous congestions are on the *left* side of the body, nor does the right participate till late in the disease. The very free communication between the cephalic vessels renders this less evident in the head; but the veins of the forearm and upper arm look in such cases almost varicose, and a meshwork of blue vessels overlying the left pectoral region is especially striking. A peculiar, soft tumor, sometimes described as spongy, but giving a sense of being made of worms, smaller than those felt in varicocele, forms over the left clavicle—a very characteristic symptom. When the right side is also involved, the aneurism will have become large; the amount of dyspnœa and of exclusion of air from the lungs must decide whether this participation results from pulmonary congestion, or from pressure on the descending cava or right innominate vein.

Treatment of Aneurisms at the Root of the Neck.—Before going on to study the surgical treatment of innominate aneurism, which I shall take up with that of the aortic arch, it will be well first to consider the measures available for the other forms just described, assuming that no one would proceed to operative measures until rest, diet, one or other form of pressure, and perhaps some other of the methods already mentioned, had been fairly tried, and had failed to produce any lasting benefit. The word "lasting" is used here because there are few cases, subject to rigid rest and unirritating diet, which fail to exhibit signs that simulate improvement. The heart and the vessels being in repose, it is only natural that the aneurism should pulsate with less force; and, unless its coats be very thin, that it should, by the mere elastic contraction of its walls on a less potent blood-stream, diminish in size. No doubt, in a certain number of cases, this immediate result is followed by material improvement, or even by cure. Other patients, having simply reached that point, progress no further. Week by week, or oftener, a full examination shows the disease in the same state; at last the exigencies of life require resumption of occupation;¹ when movement and employment immediately bring back the old rate of growth. Another and the larger series of patients experience some immediate benefit from the rest and restrictions, for the first few days; after which, and even while treatment is going on, the disease resumes its rapid progress. Under either of the two latter conditions, surgical measures should be resorted to.

Rest and Diet.—I find, of aneurisms of the subclavian, 31 treated by rest and regulation of diet, and 13 subjected to the stricter regimen and the venesections of Valsalva. Of those in the former category,² 4 were cured, but 2 of them so rapidly, or rather suddenly, that the event was evidently due to some

¹ These are the cases which, in Hospital Reports, are noted as "relieved."

² Poland gives 22 cases; the additional 9 are from my own sources, chiefly from Hospital Reports. There is no doubt that many more have occurred in different parts of the world; but a case of aneurism treated by means so little noticeable, increasing and killing the patient, would hardly find its way into print.

fortuitous impaction of clot. Cure can only be ascribed to the influence of treatment in the 2 cases which recovered slowly, that is, by gradual consolidation.

Of 13 patients subjected to Valsalva's method, 7 are reported as cured, or in process of cure; but on examination this number shrinks considerably: 2 cases (Guérin) are very likely one and the same; 2 are doubtful as to the nature of the tumor; 1 patient was not cured, passing from observation almost immediately after treatment had been begun, and with little benefit; in 1 spontaneous cure fortuitously began with or before the treatment; 1 got well during acute enteritis; 1 recovered under the influence of a poisonous dose of aconite (Pancoast).¹

Compression.—*Proximal compression* was rendered facile in a case under the care of Mr. Poland, by an arterial abnormality combined probably with the development of a cervical rib. The aneurism was cured. Another successful case recorded by Dutoit, is referred to in the sequel.

Of the results of *direct compression*, it is hardly possible to acquire any accurate numerical knowledge; probably nearly every quickly increasing aneurism has, at some part of its course, been restrained, or attempted to be restrained, by some bandage or pad; and a few of these cases have got well, as in Yeatman's case, without any clear sequence between treatment and cure;² or an accidental detachment of clot, as in Corner's case, has occurred under a protecting leather cap;³ or an accident rupturing the aneurism has caused, by the blood-pressure, obliteration of the artery and afterwards supuration;⁴ or, as in another case⁵ recorded by the same surgeon, the ten days' very moderate pressure may have set up the first increment towards gradual consolidation; or the cure may have been fortuitous and spontaneous. Indeed, the only clear case of cure by direct pressure is that of Mr. Holmes.⁶ The tumor was the size of a chestnut, and lay on the third part of the vessel; the index finger was gangrenous. The arm was enveloped in cotton-wool, and an India-rubber ball was bandaged upon the swelling with gradually increasing pressure, for about six weeks, and after five days' intermission was again employed for ten days; after this, an instrument was adapted. Gradual consolidation took place; and the man was seen a year afterwards with barely a trace of the disease—a most gratifying result, which should encourage a trial of this method, but a result which we cannot expect frequently to follow, unless, as in this instance must have been the case, there exist a great tendency to spontaneous cure.⁷

Manipulation is a mode of treatment suggested by events which occur spontaneously with such frequency that we should not exclude it from our resources, especially in dealing with a disease which offers to the surgeon so few points of vantage. It should be very cautiously resorted to in subclavian aneurism; the danger of embolism in the brain, through the vertebrals, and on the right side through the carotid also, must be duly weighed.

¹ In my table I have marked one of the Guérin cases as doubtful, put two others in the same category, and relegated the one not cured to its proper place, as also those influenced by poison and disease; this leaves one case as cured by Valsalva's method.

² Med. and Phys. Journ., vol. xxxiii.

³ Medico-Chirurgical Transactions, vol. lii. p. 303. Mr. Corner entitles his case one of Right Subclavian Aneurism cured by Direct Compression; and Mr. Poland has accepted this nomenclature. The first treatment, rest, diet, and ice, resulted in "no benefit;" then "a leather cap was moulded to the swelling and fixed on by straps." The patient resumed his occupation, and there is no note of improvement. A year afterwards "he felt himself suddenly bad, experiencing sickness and vertigo, so that he was obliged to hold on to something to prevent his falling; and on feeling the swelling afterwards no pulsation was found in it." No clearer evidence of accidental clot-impaction is possible.

⁴ Warren, Surgical Observations, p. 425.

⁵ Ibid., p. 427.

⁶ Lancet, Feb. 12. 1876.

⁷ A case by Dutoit, in which pressure aided other means, will be mentioned immediately.

I find this mode of treatment noted five times in the Hospital Reports of the last ten years, and each time as unsuccessful; while of the five cases quoted by Poland, in only one was it of avail.¹

Parenchymatous injections of ergotin appeared to be of decided benefit in the case of Dutoit, the cure being confirmed by distal pressure.² The case, as I read it, was one of fusiform dilatation of the left subclavian, just before it passes between the scaleni. Dutoit used large doses, beginning with half a grain, and rapidly increasing to three grains. After the fourth injection, the tumor began to diminish, while the surrounding tissues became exceedingly hard. After about three weeks, distal digital pressure became possible, and was used during six days—in all twenty-one hours. The aneurism became solid. But three more injections, and then an India-rubber pad and bandage, were employed. The treatment occupied five months. This case gives the most potent evidence on record that such injections may be valuable. In Langenbeck's case, that which laid the foundation of this treatment, the ultimate benefit was doubtful. I find no other instance of advantage derived from this plan; but it has very frequently been used without any good result.

Injection into the sac of perchloride of iron has not proved beneficial, and its dangers are very great, since it is impossible to obviate the flow of solid or semi-solid blood-clots along the vertebrae.

Temporary ligature and acupressure have proved even more surely productive of secondary hemorrhage than has permanent deligation. These plans were tried by Porter and Bickersteth, and will be referred to in the sequel.

Amputation at the shoulder-joint was suggested and practised by Mr. Spence,³ and the method has since been adopted by Holden,⁴ Heath (who, after amputating, also thrust needles into the sac),⁵ H. Smith, Rose, and Bellamy.⁶ Mr. Spence's patient seems never to have quite lost pulsation in the aneurism, though he survived four years. Rose also tied the carotid, and thus succeeded in curing his patient. In the other cases the procedure was unattended by any benefit.⁷

The results of these methods may thus be tabulated:—

Treatment.	No. of cases.	Cure by treatment.	Coincident cure.	Death or no benefit.	Doubtful cases.
Rest and diet	31	2	2	27	
Valsalva's method	13	1	2	7	3
Proximal pressure ⁸	1	1			
Direct pressure	1	1			
Manipulation	8	1	..	6	1
Coagulating injection	2	..	..	2	
Injection of ergot ⁹	6	1	..	4	1
Galvano-puncture	3	1	..	2	
Temporary ligature	2	..	..	2	
Amputation at shoulder-joint . .	7	2 ⁹	..	5	

¹ Fergusson's second case cannot be regarded as cured by the manipulation.

² Langenbeck's Archiv, Bd. xii. S. 1070.

³ Spence, Med.-Chir. Trans. vol. lii. p. 306.

⁴ St. Bartholomew's Hospital Reports, vol. xiii.

⁵ Med.-Chir. Trans., vol. lxiii. p. 65.

⁶ Unpublished. A case of ruptured artery after dislocation reduced by another surgeon. In the engorged condition the artery could not readily be found.

⁷ In Morton's case (Pennsylvania Hospital Reports, 1868), amputation of the arm and subsequent removal of the caput humeri, were undertaken for secondary hemorrhage after deligation of the second part of the artery, rather than for subclavian aneurism; the man recovered.

⁸ I have placed the case of Dutoit among the successes by injection of ergot, and also by proximal pressure; he insists upon this latter, but I do not understand how it was applied.

⁹ One of these cases (Morton's), referred to a few lines ago, was hardly an amputation for aneurism. Spence's patient lived, but the aneurism was not cured.

Ligature of the subclavian artery in its terminal division, for aneurism of the same tract of the vessel, would, at once, strike the surgical pathologist as a very hopeless procedure, (see p. 940), and we find that in the five cases in which this has been attempted, death resulted in three,¹ a mortality of sixty per cent. But if the aneurism be subclavio-axillary, and do not reach as high as the border of the scaleni, a better prospect is afforded.² Thus, for such disease, the vessel has been tied over the first rib twenty-eight times, with sixteen recoveries and twelve deaths; hemorrhage was the fatal complication in five cases.

The small number of cases in which the second part of the subclavian artery has been tied for aneurism, is probably due to an exaggerated idea of the difficulties of the operation. I cannot but think that this deligation might, with advantage, be substituted for that of the third part in a large number of cases, since, as already pointed out, the vessel is less often diseased at the spot where it is supported by the muscles, than elsewhere, and usually only one branch is given off from that part. I can find only nine cases of this procedure, with but four recoveries and five deaths. In analyzing the causes of death we find that only one patient died of secondary hemorrhage (Liston), and one of cerebral complications, the cause being obscure; two cases of diffused traumatic aneurism³ terminated fatally by pyæmia, and one patient died of drunkenness when nearly recovered (Gay). Thus four deaths out of the five may be considered as not intimately connected with the operation, and we may, therefore, regard them as almost fortuitous.

We have still to record seven cases in which the aneurismal sac so covered the artery that it could not be reached without exposing the patient to unjustifiable danger. Of these cases of commenced, but abandoned, operation, five ended in death; one was followed by cure (probably the result of manipulation); of one, the result is unknown.

Deligation of the first part of the subclavian artery, or of the termination of the innominate, is an operation which the surgeon would only undertake under very pressing circumstances; indeed, high authorities have pronounced it unjustifiable. But that judgment was given, and the experience whereon it was founded was acquired, before the modern improvements in the material of ligatures had been introduced. I should not, in a suitable case, decline to tie either of these vessels, although the statistics of the past (had we still to rely on silk or hemp), would, undoubtedly, deter me from any such undertaking.⁴ These statistics are as follows: eleven patients have been subjected to this operation, of whom every one died—one from pericarditis, pleurisy, and pyæmia, and nine from hemorrhage, the cause of death in the eleventh (Arendt's) case being unknown. In a twelfth case (McGill's), in which the artery was compressed with torsion forceps, death resulted from a wound of the pleura. The bleeding in the nine cases referred to took place from the distal part of the vessel, that is to say, from beyond the ligature. Thus it appears that free collateral circulation keeps the part of the vessel on the further side of the heart open, so that when the artery is ulcerated through, blood passing along the branches, enters the trunk, and makes its exit from the peripheral end of the severed vessel. For this reason Liston and Cuvillier

¹ One of Mr. Poland's cases was in reality a deligation of the second part, and I find, since the date of his papers, another case similarly incorrectly classified.

² The difficulty of determining, before exposing the artery, the exact height at which such disease may stop, is undoubted; after laying the vessel bare, however, the surgeon has the choice of placing his ligature behind the scalenus.

³ In reality a wound of the artery; it is the comparative absence of hemorrhage, that very fatal result of more central operations, on which I would especially rely as supporting the recommendation given in the text.

⁴ The method of performance is given at p. 963.

tied also the carotid, while Parker ligatured both that vessel and the vertebral. The results, however, disappointed the expectations of the operators, and bleeding occurred in the same way. In nine cases, in which the first part of the subclavian only was tied, the operation was undertaken for the cure of subclavian aneurism, and in one case for that of axillary aneurism; these, with Arendt's and McGill's cases, and the three in which other vessels also were ligatured, make up the number to fifteen, of which all, save three, are known to have terminated fatally from hemorrhage. A sixteenth case (Hobart's) belongs to and will be found in another category (aortic aneurism), while three cases (tabulated by Wyeth), in two of which the vessel was secured for gunshot wound, and in the third for vascular tumor of the scalp, do not belong to our subject; all four patients died of hemorrhage.

An alternative lies between this operation and *deligation of the innominate*, but in this choice statistics guide us very little. There have been 25 examples of this procedure,¹ and death has resulted in at least 23. In one successful case, secondary hemorrhage occurred; Dr. Smyth, of New Orleans, had tied, at the same time, both the innominate and the carotid; fourteen days afterwards, hemorrhage occurred, and was repeated, but less copiously, at intervals. At last, fifty-four days after the first operation, the vertebral was tied; the patient after this did well, and survived ten years, ultimately dying, however, of hemorrhage from the sac.

When we consider the results of these forty-four cases of subclavian and innominate deligation, we are first struck by the frightful death-rate, and, going further, by the fact that the hemorrhage has invariably come from the distal part of the vessel. This is accounted for by the very free anastomoses in the neck, but principally by those of the vessels at the base of the brain. If the subclavian (first part) be alone tied, blood finds its way down the thyroid axis, but more especially, down the vertebral into the vessel beyond the ligature, while tying also the common carotid helps but little, since blood readily passes down that artery into its branches, and so to the subclavian, as well as by way of the vertebral artery. The same thing occurs as in the last case, if the innominate alone be ligatured. Thus a question naturally arises, namely, if a certain sort of ligature could be trusted to effectually prevent secondary bleeding (the vascular coats being undivided), would deligation of the vessel cure the aneurism, unless other arteries—carotid and vertebral—were also tied? This question can only be answered by experience, such as we have as yet had little or no opportunity of acquiring. It must be remembered that a certain current through the aneurismal sac is advantageous, but we do not as yet know whether the collateral flow would not, in a large proportion of cases, be so rapid as to prevent consolidation. The condition of the aneurism is described in a few only of the recorded cases; but in most of these the sac is said to have been contracted, much thickened, and filled with clot or with laminated fibrin.

Deligation of the right subclavian artery in its first part.—The operations of tying the first part of the right subclavian and the innominate are very similar. About six slightly different modes of making the first incisions have been practised. Two only need be mentioned, viz., the method by a single transverse or oblique incision, and that by two incisions meeting at an angle: this last is the one which I should recommend.

Begin about 2½ inches above the sterno-clavicular joint, and over the round belly of the sterno-cleido-mastoid muscle. Make an incision ending on the clavicle a little outside the articulation; from this, carry outward another in-

¹ Including the cases recently recorded by Thomson, Banks, and Durante. The result of the last case is unknown. In Banks's case the subclavian was afterwards tied.

cision over the bone to a little beyond the limit of the muscle; turn the triangular flap upward and outward, tying and cutting, if necessary, the external jugular vein; then the outer edge of the sterno-mastoid being found, a director may be passed behind it¹ as far as its sternal origin, and all the clavicular portion divided. This being pushed on one side, exposes the fascia over-lying the sterno-hyoid; the director, after a little opening in the aponeurosis has been made, can be insinuated behind that muscle, which also must be severed. It is well now to look and feel for the carotid artery before going on to divide the sterno-thyroid, whose outer edge covers that vessel, and never, as far as my experience of the dead subject goes, conceals the subclavian.² The finger of the operator, after division of the sterno-hyoid, readily detects the longitudinal course and pulsation of the carotid, and may with ease push the edge of the sterno-thyroid from off its sheath, inward, in which position the muscle should be held with a blunt hook. When thus the sheath of the vessel is brought into view, the operator should look for the large veins that always, but more especially if there have been dyspnoea, overlies it. Choosing a vacant spot, he merely nicks the loose structure in which they lie, and then pushes them up and down, tearing the cellular tissue a little, till the dense fibrous sheath is bared sufficiently—first, to have a small opening made in it, and then to be slit up. This should be done on the front, inner aspect. Now, at this part the vein diverges a little from the artery, so as to leave a triangular interval through which the vagus nerve runs. A blunt hook is placed over this, and it is to be drawn with the jugular vein gently outward. The next point is to find the subclavian. To do this the operator must remember that the usual description and delineation of the innominate bifurcation is incorrect. It is generally depicted as though the two branches arose side by side and almost at right angles to each other. In reality, the subclavian springs behind the carotid, and the angle between the two vessels is very acute; therefore, to detect the subclavian, the operator must place his finger at the back, outer aspect of the carotid, when, passing it down, he comes generally, a few lines above the clavicle, to the slightly divergent pulsating line of the subclavian, which lies deeper than the carotid by the whole diameter of that vessel.³

In selecting the spot for placing the ligature, it is well not to put it quite close to the bifurcation, but also not too near the border of the scaleni, lest the recurrent laryngeal or the phrenic nerve should be injured. The pneumogastric nerve and the jugular vein should be kept not too forcibly outward, and the needle should be passed from below, while with his left forefinger the surgeon gently presses the pleura downward and outward. Some obstruction behind the artery will very likely be encountered, but it is better patiently and gently to overcome this, and never on any account to attempt to pass the needle the other way; for if this be attempted, the point of the instrument is certain to penetrate the pleura.

Having now passed and tied the ligature, the surgeon should consider the advisability of also securing the vertebral artery. It lies in the groove between the longus colli and the scalenus, so that the jugular vein must now be held

¹ It may, by an operator sure of his hand, be cut freely.

² The mere division of the muscle is in itself unimportant, but there lies behind it a plexus of large veins, passing from the thyroid body to the internal jugular, generally distended by the dyspnoea accompanying aneurism at the root of the neck. Their division causes profuse bleeding, and subsequent difficulty in recognizing the deeper parts. This happened in both of Auvret's cases, while the fortunate knife of Colles missed a large vein just behind the muscle. Hayden, too, encountered severe bleeding when dividing the sterno-thyroid.

³ In one case, owing to the depth of the vessel, Liston thought it might arise from the aorta to the left of the right carotid, and pass to the right scaleni behind the oesophagus. This, of course, may have been the condition of things, but, also, he may have been mistaken.

inward; the dissection already made will have so nearly exposed the artery, that a few touches with a director will lay it sufficiently bare to allow the passage of the needle. The position of the phrenic nerve on the anterior scalene muscle, outside and a good deal in front of the vessel, guards it against much risk of injury, but still it must be carefully avoided. The operator must not mistake the inferior thyroid branch (which is, however, much smaller, and usually at this part external) for the vertebral artery itself.¹

Deligation of the Innominate Artery.—If it be intended to tie, not the subclavian, but the innominate, or if the former artery be found so diseased as to render deligation hazardous, the same incisions and dissection will suffice for passing a needle round the brachio-cephalic trunk. In most cases, however, it may be necessary to divide the round, sternal origin of the sterno-mastoid muscle, and in some the outer fibres of the sterno-thyroid. The surgeon's finger, passed down the carotid as above described, impinges on the innominate at its bifurcation, the only part which, without removal of bone, is attainable.² Unless, as sometimes happens, the innominate be shorter, that is, divide lower, than usual, its extreme end can be drawn up into the neck by throwing the head well back. If the respiratory difficulties of the patient prevent this, or a low bifurcation render it ineffectual, a device which I have had more than one occasion to use on the dead subject may be resorted to, unless the carotid is aneurismal or much diseased, namely, to gently grip that vessel in a pair of smooth jawed (non-serrated) forceps, and, by drawing it upward, lift the end of the artery from behind the sterno-clavicular joint. The fascia on each side of the vessel, that is, just below the subclavian, and inside and below the carotid, should be incised or torn to facilitate the passage of the needle. After tying the artery it will probably be safer, not merely as obviating distal hemorrhage, but for the future course of the aneurism, to tie the carotid also. The vertebral will probably lie behind the aneurismal sac; if not, that vessel also may be secured without enlarging the incision, or indeed adding to the danger of cerebral complication.

These operations are in all cases sufficiently arduous to demand from the surgeon all his coolness and skill; but when the aneurism lies over or very close to the part to be ligatured, when the disease displaces the vessel and changes its relations, when anatomical irregularity exists, all the difficulties become enormously enhanced.³

Deligation of the innominate artery, first performed by Valentine Mott, of New York, presents us with a ghastly list of deaths, every operation except one (Smyth, of New Orleans) having proved fatal, and by hemorrhage. Nevertheless, if we examine the events of each case, it is evident that this operation would not be necessarily fatal if a ligature were employed which, by leaving all the coats of the vessel entire, could not be followed by bleeding at the site of deligation. Mott's and Hall's patients walked about (most imprudently), one on the twenty-third, the other on the third day. If we except Bickersteth's case (temporary ligature), and Hutin's (not aneurismal, but a case of punctured wound), we find the patients living not a few hours only, but days, until, namely, that dangerous moment for silk and hemp, the time of separation of

¹ In certain cases, the aneurismal sac overlying the vertebral artery renders it inaccessible.

² Cooper (San Francisco), in a case of large aneurism, removed the upper part of the sternum and a portion of the clavicle; but when it is considered how frequently in thoracic aneurism part of the sac is formed by these bones, the danger of such a procedure will be evident; Cooper's patient lived thirty-four days.

³ We find: pleura wounded, one case (Colles); severe bleeding from veins under sterno-thyroid, three cases; abnormal arteries divided, two cases; abandonment of operation on account of position of sac, four cases; while in one case (Liston) great difficulty was found in reaching the subclavian, which was supposed to arise from the aorta and to come into the right side of the neck behind the œsophagus.

the ligature, arrives. Sixty-seven and sixty-five days are the longest periods of life, but whether long or short, the mechanical action of insoluble ligatures—the severance of arterial coats—is the immediate cause of death.

To the record of completed cases, we must add four of abandoned operation. One surgeon finding the innominate too diseased, tied the carotid;¹ two other surgeons simply desisted; in one case (Key) complete, in another (Porter) partial solidification resulted from the manipulation, or from an inflammatory condition set up in the coats of the sac.

As regards hemorrhage and the insoluble ligature, the same remarks apply; all the recorded cases (except Smyth's) have proved fatal, but the necessity of such a mortality with a different form of ligature is very doubtful, and is at all events not proven.²

Deligation of the Left Subclavian Artery in its First Part.—If the operation of tying the first part of the *right* subclavian artery be difficult, the deligation of the *left* vessel is hazardous in the extreme; the artery on this side lies more deeply, passing into the neck out of the thorax from behind the lung, nor does it rise as high above the first rib: it is almost longitudinal in direction—the internal jugular vein and the vagus nerve are dangerously near and parallel to the vessel—while in front and on the inner side, and somewhat outside, is the pleura. Thus the deep incision, in which the work must be done, offers hardly any space, and when we add the possibility, even probability, that even this narrow area may be still further diminished by encroachment of the aneurismal sac, it will at once be understood that the operator must be bold and confident who would undertake such a task; nevertheless, the deligation has been effected once, by Dr. Kearney Rodgers, of New York,³ whose description of the operation, as both instructive and monitory, may here be abridged.⁴

The external incision was the same as that above described for tying the right subclavian; the inner three-fourths of the sterno-mastoid muscle was divided.⁵ On turning up the muscle, a portion of the aneurismal sac, strongly pulsating, was brought into view overlapping half the width of the scalenus. The fascia being torn, the deeper work had to be carried on between the aneurism on the outer, and the jugular vein on the inner side, aiming at the inner edge of the scalenus, half an inch above its origin, so as to avoid the thoracic duct; when this point was reached, the vessel was found without difficulty by pressing the finger downward. The needle with removable point was used to pass the ligature, "great care being necessary to detach the artery and to avoid danger to the pleura and thoracic duct." Very little immediate shock followed the operation. On the tenth day, a cough commenced; on the thirteenth, secondary hemorrhage set in, and the case terminated fatally on the sixteenth.

At the autopsy, "a large, irregular, lacerated opening was found in the pleura," and the cavity was filled with coagulated blood. "The artery had been completely divided by the ligature, which was found loose in the wound. The stump of the subclavian, between the aorta and ligature, presented the appearance of a round, solid cord, about one and a quarter inches long, impervious to water and air." Beyond the ligature, no plug other than a soft, quite recent clot, occupied the lumen of the artery; the vertebral was given off immediately at the point of ligature, and contained a like clot, evidently formed only just before death; the internal mammary, also, was patulous and healthy.

¹ Afterwards the subclavian was ligatured by A. B. Mott; see table of cases of consecutive double distal ligature.

² See Appendix to this Article, containing account of Mr. Thompson's case of innominate ligation with the ox-aorta ligature.

³ Sir Astley Cooper tried to tie this vessel, but abandoned the attempt, believing that he had wounded the thoracic duct.

⁴ The case is given at length in the New York Med. Journal, 1846.

⁵ It is not stated what was done with the sterno-hyoid and sterno-thyroid muscles; they are simply mentioned as seen, covered by the fascia.

The complete division of the artery by the ligature, and the open state of the distal part of the vessel, require no further commentary than a reference to what is said at p. 893. The opening observed in the pleura shows that this membrane was probably wounded in spite of the surgeon's great care.

Temporary compression or ligature of the innominate has been resorted to by Mr. Porter, of Dublin,¹ and by Mr. Bickersteth, of Liverpool.² The former used his artery compressor—an instrument like two aneurism needles sliding one within the other, or like a minute lithotrite; the latter employed a somewhat complicated appliance, whereby he hoped to compress the artery by an elastic force connected by lead wires to the pressure-bar passed beneath the vessel. The former instrument failed by causing a slough of the artery; the latter by the giving way of one of the wires. Mr. Bickersteth then tied the vessel on each side of the part that had been compressed, with the usual result, secondary hemorrhage, beginning on the seventh day, recurring, and destroying the patient in twenty-four hours.³

Deligation of the axillary artery for subclavian aneurism has, as a distal operation, every possible defect, many vessels being given off by the diseased part of the artery, or between the sac and the ligature. The procedure has been employed five times, and in each instance certainly did no good, but probably hastened the fatal termination.

The next aneurismal tumor at the root of the neck, of which the treatment is to be considered in the order we are pursuing, is *low carotid aneurism*, by which words it is intended to indicate a tumor placed so low in the neck that a portion of it is situated below, on a level with, or just above the clavicle. This position offers the surgeon no opportunity to apply a ligature anywhere between the tumor and the heart, unless he have recourse to tying the innominate. Hence the treatment is restricted to a tract of vessel beyond the sac, to what are called distal methods. Distal pressure on the carotid is unpromising, because it has to be applied higher than Chassaignac's tubercle, at a point where the patient cannot possibly bear it for a sufficient length of time, if it be directed backwards. The only feasible method, therefore, is that practised by Rouge,⁴ which has already been described (p. 947), as have also the possible advantages and very certain dangers of the rapid mode of employing compression. If rest and pressure fail, we have no recourse but to place a ligature round the carotid on the distal side of the aneurism.⁵ This operation was first formulated and practised by Wardrop, who especially pointed out its applicability to the carotid, since no vessel is there given off between the ligature and the origin of the artery.

A *distal deligation of the carotid* should be practised above the omo-hyoid muscle, and not far from the bifurcation. The method of performance has already been described, but I would point out that an aneurism may considerably displace the vessel, and that care in studying the part and its vicinity should therefore in every case be used.

In this operation the pulsation of the aneurism does not cease, as in the proximal deligation. When the ligature is tightened, indeed, it may for a few seconds increase, but the tumor should not increase in size. Such an event would be of bad augury, as indicating danger of future rupture. Shortly after, a noticeable but not very great decrease in size can be verified,

¹ Dublin Quart. Journ. of Med. Science, Nov. 1867.

² Medico-Chirurg. Trans., vol. lvi. p. 129.

³ I am not aware that the instrument of Dr. Fleet Speir has been used on this vessel. For remarks on temporary ligature, see p. 889.

⁴ Rouge's case was cured in 136 hours—viz., 8 hours daily during 17 days.

⁵ Neither electrolysis nor injection of coagulants is applicable, since cerebral embolism would almost certainly follow.

and slowly the pulsation diminishes. We have not sufficient experience to fix any date for its cessation; indeed, in certain cases, as when the aneurism is placed very low, pulsation may be communicated to the solidified tumor from the innominate on which it rests. I find but a few cases on record of this operation, for carotid aneurism pure and simple, and at least three of these terminated fatally.¹

This paucity arises from the fact that low carotid disease, even though commencing simply in that vessel, has a great tendency to spread downward, and to encroach upon the end of the innominate; but chiefly because it is probable that most of the aneurisms developed in this place begin, as so many aneurisms do, at the point of bifurcation of the latter vessel. Of course an aneurism commencing at that part may spread upward on the carotid, laterally to the subclavian, or in both directions. They remain, however, high innominate aneurisms, although they are frequently called carotid or subclavian aneurisms, involving the innominate.

Innominate aneurism, when diet, rest, and medicine have failed, is hardly amenable to other form of surgical treatment than operative. The surgeon may, indeed, try galvano-puncture, the statistics of success and failure of which have already been given. Pressure, if used at all, can only be distal; nor can it be expected, as a rule, to yield any good result; yet the fact must not be overlooked, that one case of innominate aneurism is reported to have been cured, or greatly benefited, by this method.² The instrument used was a modification of Bourguery's compressor for subclavian aneurism, namely, a broad leather belt round the chest, bearing an oblique strap, which, fastening to the left side of the belt, back and front, passed over the right shoulder, and kept a pad firmly pressed on the subclavian. The corset carried behind a steel plate, bearing an upright rod, terminating above in an adjustable lever, with screws, pads, etc., whereby compression could be made on the carotid. The laryngeal symptoms and occasional faintings, previously distressing, disappeared in a week; at the end of three months the instrument was laid aside, and the patient returned to her usual household duties. The report was written ten months after treatment had been abandoned, the patient, if not cured, yet living her usual life. The means appear very inadequate to the end in view and to the success obtained; no doubt there must have been in the patient a great tendency to spontaneous cure. Still, the case is, as far as it goes, important, as showing the possibility, however remote, of aiding recovery by distal pressure.

The operative treatment of innominate aneurism has, of late years, greatly interested the surgical profession, many having attempted to realize Wardrop's views regarding distal ligature. It is unfortunate that that surgeon, in his well-known case (Mrs. Denmark's), should have erroneously supposed his patient's right carotid to be obliterated, so that he tied only the subclavian, in its third part. Even with this inadequate operation the patient was greatly benefited, but died two years after, a large aneurism of the innominate still persisting.

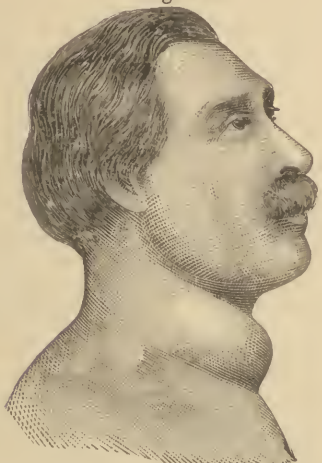
The method thus inaugurated, was repeated from time to time by other surgeons, with certain variations to be immediately described, but without

¹ My figures differ from those of both Dr. Wyeth and Mr. Holmes. The names of the operators are as follows: Wardrop, Bush, Lambert, Wood, Montgomery, Lane, and Colson (de Noyon). [Additional cases, raising the number to ten (with four deaths), are recorded by Denm  , Delens, and De Mello Ferrari; an eleventh case is attributed to Barbosa.] Like Mr. Holmes, I count but one case to Wardrop; the vessel in his other case bore on post-mortem examination no sign of having been tied. I add to each list certain other cases. Several cases diagnosed as examples of pure carotid aneurism have been afterwards proved to belong to a different category.

² A. M Edwards, *Lancet*, Jan. 9, 1858. The case appears to have been overlooked by most, if not all, writers on this subject. At least I do not find it quoted in any work that I have searched.

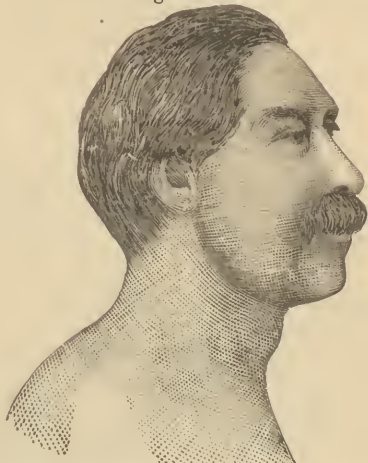
much success, until 1865, when Mr. Heath tied simultaneously the right carotid and subclavian for a woman supposed to be suffering from innominate aneurism,¹ who survived four years in spite of the most wretched, drunken habits. In 1872, an excellent study and *résumé* of the subject, by Mr. Holmes, kept up an interest which had never greatly flagged.² Nevertheless, no successful instance of this mode of treating innominate aneurism had occurred until August, 1877, when I tied simultaneously the right carotid and subclavian in the case of Robert Watson, illustrations of whose case, before and after the operation, I subjoin.³

Fig. 548.



Case of Robert Watson ; innominate aneurism.

Fig. 549.



Case of Robert Watson, seven weeks after operation.

In thus dealing with an aneurism of the innominate by attacking its branches, it is evident that a certain choice lies open to the surgeon. He may either elect to tie, at the same operation, the common carotid and the subclavian, third or first part, or he may ligature one of these vessels as a first step, reserving the other to some favorable opportunity. These procedures are called "double distal ligations," the former being qualified as "simultaneous," the latter as "consecutive." Or he may content himself with tying only one of the vessels in question, the one selected being usually the carotid, though in a few instances the subclavian only has been tied. Having then this wide choice, the surgeon requires certain grounds upon which to base his decision: first, as to the propriety of adopting any operative measure; and secondly, as to what that measure should be.

The former consideration is at the present day of very vast importance, because the method of double distal ligature has, of late years, received a great impetus; it is also one in which I am personally interested, as much of that impetus has been imparted by my own successes and writings. By the results of surgery in this department, during the next few years, posterity will judge the justifiable or unjustifiable nature of the procedure. Now success in great measure depends upon a judicious selection of cases; while want

¹ After death, the aneurism was found to have been aortic. The case is reported in the *Lancet*, Jan. 5, 1867; the preparation is in the College of Surgeons' Museum, Pathological Series, 1596 A.

² Lectures on the Surgical Treatment of Aneurism, delivered at the College of Surgeons, and published in the *Lancet*, 1871, 1872, 1873.

³ By kind permission of the Council of the Medico-Chirurgical Society, in whose *Transactions*, vol. lxi. p. 32, the case is published. The aneurism was cured, but the man exposed himself, insufficiently clad, to most inclement weather, and died of bronchitis, quite independent of the original disease, six months afterwards.

of judgment or insufficient care in examination will most certainly bring a valuable operation into disrepute. For the guidance of the surgeon, I would submit the following aphorisms:—

I. An aneurism commencing suddenly, especially if traceable to some traumatism or over-exertion, is more likely to be benefited by operation than one arising gradually and without assignable, mechanical cause.

II. Distinct sacculation is a most desirable condition; fusiform dilatation of the innominate indicates almost certainly a similar condition of the aorta, and widespread arterial disease.

III. If symptoms show the aortic arch to be also affected, the disease should be limited, that is, should not extend along the transverse portion; it should be of the sacculated variety, not a general dilatation of the whole calibre. Absence of any other aneurism, especially of the rest of the aorta, must be ascertained.

IV. Absence of rasp-sound along the aorta, or any other indication of extensive atheroma, should be verified.

V. Aortic incompetence (obstruction, regurgitation, or both), unless very slight, is a decided objection, as is also mitral disease or considerable hypertrophy of the heart.

VI. Patency of the vessels leading to the brain should be investigated by making a few seconds' pressure on the carotids alternately, and then simultaneously.

VII. Absence of visceral disease must be ascertained.¹

The choice of tying both vessels at the same time, or of at first securing one only, must depend in part on certain peculiarities of the aneurism, in part on other matters concerning the circulatory organs. In regard to this question I would offer the following rules:—

I. If the aneurism occupy the distal end of the innominate, with the root either of the carotid or of the subclavian, but not of both, then we may tie the one or the other respectively.

II. If there be only a moderate degree of aortic incompetence, such as might, however, be dangerous for simultaneous deligation, the surgeon must carefully consider whether its amount would also preclude tying a single vessel.

III. Aortic dilatation may be such in amount as would permit of tying one, but not both vessels, without danger.

IV. Any strong suspicion that the left carotid, or either vertebral, was blocked, would negative deligation of the right carotid, but not of the subclavian in its third part.

V. In all these contingencies, except the last, the value of a subsequent deligation of the other vessel must be gathered from the manner in which the first operation has been borne, the amount of good effected, and the changes produced in the direction of aneurismal growth.

VI. When none of the deterrent circumstances are present, and when the aneurism of the innominate does not markedly obtrude on one branch to the occlusion of the other, both vessels should be tied.

ANEURISM OF ARCH OF AORTA.

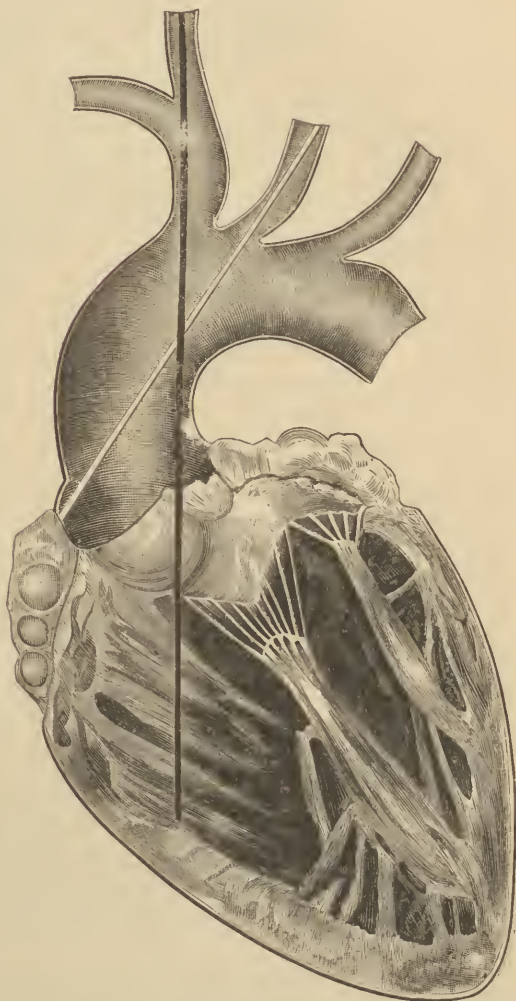
We now come to a subject, the surgical aspects of aortic-arch aneurism, which involves the latest developments of the surgery of vessels. In the

¹ Many a case has been placed on the debit side of the account when the aneurism had been cured, or was in process of cure, the patient having died of some other disease, the symptoms of which had been disregarded or overlooked. Some of these aphorisms may appear superfluous, but they are all justified by records.

year 1869, Dr. Cockle called attention¹ to several cases in which aneurism of the aorta had been cured, or greatly benefited, by obliteration of the left common carotid artery, whether by accidental impaction or by the surgeon's art, under the influence of a mistaken diagnosis;² and he recommended that in certain cases (which he did not very clearly define) of aortic disease, the left carotid should be tied in the neck. Shortly after, a suitable case presented itself, and under Dr. Cockle's supervision, Mr. Heath performed the operation. The practice has since been followed by Mr. Holmes and by myself, with incontestable benefit.

I was assiduously going through this whole subject, studying the results of operation and the causes of success or failure, when it appeared to me that Dr. Cockle's theory did not by any means exhaust the subject; and this idea was confirmed by considering cases of aortic aneurism, indubitably benefited, perhaps even cured, when the diagnosis had been incorrect, and when, under error, treatment had been directed to the innominate by tying vessels on the right side of the neck. This appeared to me connected with a curious fact in pathology. A concretion detached from an aortic valve almost invariably finds its way into the left carotid, occasionally into the left subclavian; into the right carotid about once in twenty-five cases. Hence it has been assumed that the left vessel lies more fully than the right in the axis of the ascending aorta. The very reverse is the fact, as may be proved by making a little puncture in each carotid just below its bifurcation, and passing long probes down both, as far as they will go, when, on removing the chest-wall and opening the aorta, the two probes will be seen crossing each other within the vessel. The right probe passes through the aortic opening not far from its left margin, and is well within the ventricle. The left probe strikes the tendinous ring of the aortic orifice on the right aspect of the vessel. In some bodies the end of the instrument will be just within the heart; in

Fig. 550.



Axes of heart, aorta, and carotids.

¹ *Lancet*, 1869, vol. i. pp. 422 and 489.

² See hereafter the cases of Montgomery, Tilanus, and Rigen; when error has been committed, the aneurism has been diagnosed as of the left carotid itself.

most it will be in the sinus of Valsalva. The probe is never in the axis of the aorta, but strikes the wall, be it of vessel or of ventricle, at a considerable angle.

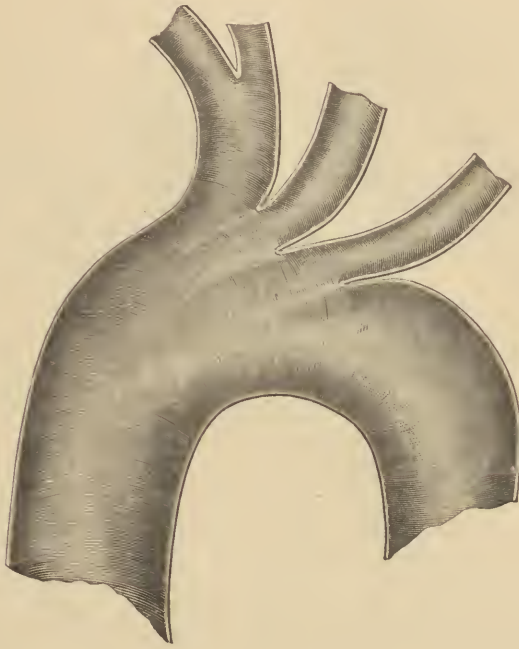
There must, therefore, be a truer anatomical cause for this propensity of detached concretæ. Solids within a stream, if not too heavy, go with the strongest current; hence we may infer that some subtle curve or slope of surfaces directs the most potent rush of the stream obliquely athwart the vessel, towards the orifice of the left carotid. Looking at the position of parts, it appears highly probable that this is really so. For the axis of the left ventricle is not in a line with that of the first part of the aorta, but, if prolonged from the apex through the centre of the orifice, falls upon and about the outer sinus of Valsalva, whose concavity appears well calculated to divert and reflect the blood-stream in the direction indicated. In this course the current would pass from the right aspect of the aortic, obliquely towards the carotid orifice; it would occupy that portion of the trunk which in the diagram lies to the left of the whole probe (Fig. 550). Possibly the potent flow of blood in this direction is associated with the preponderance of the left brain and the right half of the body.

Another matter must be pointed out, namely, the anatomical arrangement whereby each vessel is enabled to divert and gather from the general current in the aorta, that portion of the stream necessary for the supply of its own channels and branches. First, we see the great brachio-cephalic trunk; then, be it observed, there is no interval between that and the left carotid. There is not, as is usually figured and imagined, between these two vessels a bit of transverse aorta, convex upward, but a mere angle, a sort of V-shaped double septum; a rather wider angle separates the left subclavian from the carotid. If the lower part of the ascending aorta be severed from the rest, and we look along the tube of the transverse part, we do not see the orifices of the carotid and subclavian foreshortened into ovals, or mere slits, as would be the case if these vessels were given off straight and plumb from the parent stem. On the contrary, these openings face us directly, so that we seem to see right into the lumen of each branch, and chiefly into that of the carotid.¹ This results from the mode of origin of these vessels. They are not given off straight and rectangularly from the transverse aorta, but their roots take a very oblique direction to the left, and then swerve more directly upwards; hence the distal margin of each vessel lies on a level considerably lower than the proximal. Each such margin has running from it, downward and to the right, on each side wall of the aorta, a rounded ridge, so arranged that the projection of the distal lip and twofold spur—in shape not unlike a half-funnel—catches the blood-stream as it courses along the main trunk, and directs each its own share into its special branch. The arrangement of these ridges is such that they divide all the upper aspect, and a considerable part of the side wall, of the aorta, into districts, one for each vessel. Hence an aneurism, unless it spring from the inferior, or concave wall, of the arch, must almost of necessity belong to the district of either one branch or the other (Fig. 551). In some bodies, however, the left carotid springs from the angle, as it were, between the aorta and innominate. In such instances,

¹ In my article in the *Medico-Chirurgical Transactions*, vol. lxii. p. 393 *et seq.*, being anxious to accentuate the absence of foreshortening, I said, "These openings look nearly round." The expression was infelicitous. Every careful anatomist knows that the openings are not round; their shape is different in different individuals. The general condition is that the innominate and subclavian openings are nearly semicircles, having their flat sides opposed at a considerable angle to each other, so that they are more widely separated in front than behind. In the wider part of this interval, and generally anterior to both the other orifices, is the opening of the left carotid, rhomboid in shape, and with its short end behind, so as pretty accurately to fit the above-described interval.

the ridge on the distal margin of the brachio-cephalic trunk is particularly strongly marked, and there is also a smaller ridge in the innominate itself, running from the proximal opening of the left carotid. In two dissections, I have found the left carotid arising altogether from the commencement of the

Fig. 551.



Arch of aorta and large branches, showing oblique roots of great vessels, and ridges running from orifices on aortic walls.

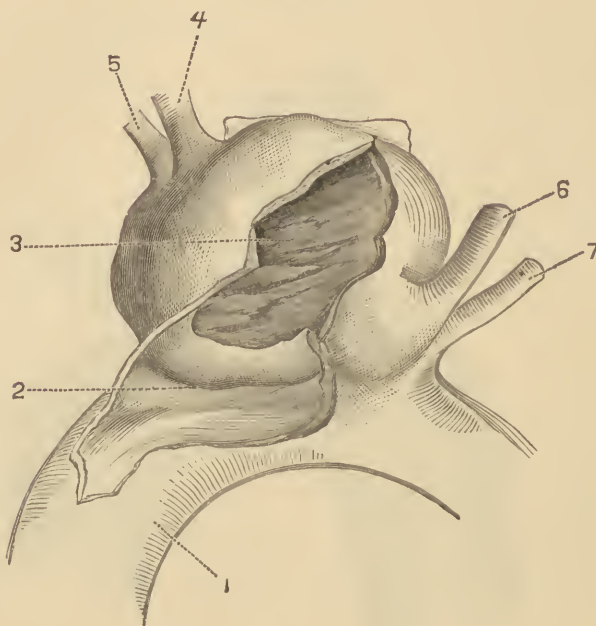
innominate. An aneurism of that vessel, occurring in such a subject, would give rise to some considerable embarrassment of diagnosis, and many doubts as to which point should be chosen as that to which surgical treatment should be directed. For instance, this was evidently the original state of the vessel in the aneurism here depicted; in the preparation, the peculiar anatomy of the left carotid can be more clearly made out than in the drawing (Fig. 552).

Now if these conclusions be correct; if there be in the aorta varying rates of current, and if there be districts of that vessel appertaining to the different branches, so that the blood which flows over or near any particular portion of its wall must pass into a given vessel, it follows that an aneurism in one situation, if amenable to surgery at all, must be treated from the vessels of the right side, while in other situations it must be attacked from the left.

Any special *résumé* of cases is impossible: my views were carried out, first, in my own case, and have since been followed by Dr. Lediard and Dr. Wyeth; these, as far as I know, are the only three cases in which double distal deligation has been knowingly undertaken for aortic aneurism. My patient lived fifteen months in fair health and comfort. Dr. Lediard's lived nearly ten months. Dr. Wyeth's died one year after the operation, from exhausting diarrhœa. That gentleman writes me: "Both arteries were obliterated at the points of deligation; they were not divided, but were

strong and fibrous, and the ligatures had disappeared. A gratifying and perfect success." The cases operated on under mistaken diagnoses have also done well in those instances in which the sac arose from the portions of the aorta about to be described, but badly when from elsewhere.

Fig. 552.



Aneurism of innominate, involving aorta and left carotid; 1, aorta; 2, wall of sac thrown down; 3, laminated clot lining aneurism; 4, right carotid; 5, right subclavian; 6, left carotid; 7, left subclavian.

We cannot then deny the possibility, and, if we could be certain of diagnosis, the high probability, of being able to benefit by operation some aortic aneurisms developed from certain definite regions of the arch. But to make his efforts valuable, the surgeon should be able to effect this, not merely in a few felicitous and fortuitous cases, while the less fortunate patients suffer injury; there should be in no case any haphazard element, but a clearly formulated view of what is to be done and what is to be gained. To attain such prescience, many difficult and minute problems in diagnosis must be solved.

The only forms of aortic aneurism with which surgery can cope, are the sacculated, and perhaps a few of such dilatations as occupy but a very limited and defined portion of the trunk. The former is more favorable than the latter form of disease. Fusiform enlargements, occupying a considerable length of the vessel, are not amenable to surgical treatment; nor indeed would I operate upon any case, whose symptoms did not permit of fairly clear and distinct definition of the place whence the aneurism arose. The method of doing this has not as yet been fully developed. Till of late years, when once an aortic aneurism had been detected, enough appeared to have been done; and even now many medical men do not think it needful to discriminate between tumors which spring from one, and those which arise from another part of the arch.

But the value which modern views on this subject have placed on more accurate diagnosis, will insure greater precision; and therefore symptoms, and

combinations of symptoms, which we may not as yet thoroughly understand, will prove to future investigators of much significance. Especially must this be the case in the early phases of the disease; the later stages, unless a history of the commencing phenomena furnish a clue, may still be undecipherable.

These points being premised, we may go on to consider the symptoms produced by aneurism of the aortic arch generally, and at first without reference to the order of their appearance.

(1) Tumor, pulsation, dulness, and certain sounds, depend upon the growth of an aneurismal sac from the artery, extending towards the surface, and displacing resonant lung by non-resonant blood (fluid or solidified). When the aneurism comes within a certain distance of the surface, the chest-wall protrudes, at first by mere bulging, but afterwards by a conical *tumor*, which visibly and sensibly *pulsates*. Around the point of strongest pulsation, a space of gradually diminishing impulse is traceable; so, too, *dulness* is in the middle of the space absolute, further out relative only, diminishing more and more until it merges into resonance; the dull area is usually continuous at one of its margins with cardiac dulness. Over the pulsatile enlargement, the *heart sounds* are heard with abnormal loudness, but the second sound is much more accentuated than the first; it is sometimes a dull, heavy thud, and in other cases a sharp, metallic ring, but it is always loud in proportion to the first sound, and even louder than over the heart itself. *Bruits* have hardly been mentioned hitherto, because their presence or absence is so variable; they are of different qualities and degrees, from a mere "coo" to a harsh, saw-like noise. Many cases run their whole course without any such abnormal sound; others are accompanied throughout by bruits; while in still a third series, the murmur—blowing or rasping—may be heard, either at the beginning or end of the case, while the intermediate portion of its course is marked by silence. These sounds, then, when present, are valuable symptoms, but their absence does not negative the existence of aneurism. We may group this whole range of phenomena under the term "tumor symptoms."

(2) Changes of the *pulse* are important, and are of different sorts. An artery may be partially obstructed by an aneurism springing from another vessel, curling over and pressing on its trunk; or, indeed, by a non-aneurismal tumor. The ambiguity which would arise from such a condition must be cleared away by examination of other symptoms. The direct influence of an aneurism on the pulse of the vessel from which it springs, is a reduction of the beat of the vessel below the tumor; it does not necessarily follow, though it is usually the case, that less blood finds its way along the tube, but it does so in a more even manner. A familiar, though not perfectly accurate, simile may be taken from the mechanism of a fire-engine (the heart), which delivers water along the hose (artery) in an even stream, although its force is imparted by alternate strokes of the pump. This is effected by letting the water first pass into a cavity—kettle I believe it is called—from which the hose issues. Now, the kettle contains at the top a little air, whose elasticity, acting as a spring, diminishes, if it does not quite eliminate the intermittent or pulsatile quality of the current. The aneurism has in it no air, but the widening of the channel at a point between the heart and the artery examined [together with the elasticity of the sac-wall] is sufficient to moderate, though it does not altogether suppress, the pulsatile character of the stream.

Thus, the sphygmographic trace shows a sloping and low upstroke, and an absence of tidal and dicrotic waves, so that, for instance, in an aneurism of the innominate, or of either subclavian, the line may represent a mere succession of even and shallow undulations. This is represented to the finger by a weak, full, soft pulse—indicating an artery which throbs slightly, never empties

itself, and, not having the stimulus of the expansile throb, does not contract fully. An aneurism situated less directly on the course of the artery examined, causes changes less easily described, because more varied—a less sloping upstroke, and all beyond represented by a zigzag line running down to the bottom of the next upstroke—and to the finger gives the sensation of a weak pulse, with a thrill or vibration.

(3) *Dyspnœa* and other *respiratory troubles* are among the most distressing symptoms of aneurism at the upper part of the chest and root of the neck; indeed, many cases of the disease prove fatal merely by obstruction of the air-passages. These troubles are of two kinds, produced, the one by direct pressure on the trachea, bronchi, or both, the other by interference with the recurrent laryngeal nerve. Nor are these forms difficult to distinguish from each other. The first produces dyspnœa from obstruction, and on applying a stethoscope to the chest, a peculiar, harsh, loud, bellows or organ-pipe sound, is heard, at first only on inspiration; afterwards, when the obstruction is more marked, the expiratory murmur is altered in a like manner. If the pressure be on the trachea, this sound is equal in both lungs; if it be on a bronchus, it will be very much more marked on one side than on the other. It is always heard on both sides, unless the point of partial occlusion be very low down, since the irregularities in the current of air affect the stream much above the actual seat of obstruction, though more slightly. Subsequently, if the bronchus become altogether closed, no sound—not even the respiratory murmur—is heard. These symptoms are continuous, but every now and then there arise severe paroxysms of violent efforts for breath; the chest heaves, the veins of the head and neck swell, the face becomes livid, a little air wheezes in and out, and severe, brassy cough adds to the distress until a little thick mucus is expectorated. The quieter phase is then restored until another mass of secreted material obstructs the already too narrow channel. With all this, the voice, unless in the exacerbation, is not particularly weakened; nay, sometimes it is rather loud and metallic.

The other form commences with changes in the voice, first of all in the tone, which is high, squeaky, and false—or whispering, with muffled falsetto. If dyspnœa occur at all, it does so early in the case, the symptoms resembling those of *laryngismus stridulus*.¹ It is under such circumstances also paroxysmal, but less frequent and more periodical than in the previously described variety. After an interval, aphonia, sometimes complete, sets in, and there may be considerable tendency to choking at meals, that is, to the food passing into the wind-pipe. Examination with the laryngoscope will show that the former condition depends upon tightness (spasm) of one vocal cord, rarely of both; the latter on paralysis.² In some cases the dyspnœa and violent cough (tracheal or bronchial symptoms) coexist with the laryngeal troubles.

(4) *Dysphagia* from pressure on the œsophagus is nearly always a later sign than tracheal or bronchial dyspnœa. The patient finds a difficulty in swallowing, at first solids, and afterwards even liquids. By listening a little on the left side of the last cervical or upper dorsal vertebræ, while the patient is swallowing a teaspoonful of water, a prolonged, reduplicated effort at deglutition will generally reveal, even before the patient is himself aware of it, obstruction in the gullet.

¹ Tracheotomy has been more than once performed.

² Dr. Bäumler and Dr. George Johnson showed specimens, in 1871 and 1872 respectively, in which, by the pressure of an aneurism, both vocal cords were paralyzed (Pathological Transactions, vol. xxiii. p. 66, and vol. xxiv. p. 42). In both cases, however, there must have been considerable pressure on the trachea itself (in the former only is it distinctly mentioned), and to this I would attribute the partial paralysis of the right laryngeal muscles, the nerves of which were not directly compressed by the sac. The fact that such tracheal obstruction can take place, must inculcate caution in the interpretation of this symptom.

(5) Another symptom is *irregularity of the pupils*, either dilatation or contraction, from irritation, and afterwards impeded function, of the sympathetic, and perhaps also of the vagus.

(6) *Displacement of the heart* downward and to the left, and certain pains in the depths and at the back of the chest, afford valuable though somewhat negative data for diagnosis.

(7) One of the most important symptoms is produced by pressure on the veins, causing *congestion* of different parts, often a *doughy lump* over one or both clavicles, and *œdema* about the face or arms. The significance of the localities of congestion depends in great measure upon their relation to other pressure symptoms. Certain combinations furnish remarkably positive evidence. For instance: pressure wholly and entirely on the right bronchus; congestion of both arms and both sides of the head and chest; tumor symptoms, chiefly about the second space and rib, considerably to the right of the sternum; heart displacement, if any, directly outward; the pulses equal, with very slight sphygmographic change—perhaps a rather sloping upstroke, usually a flat, blunt apex, absence partial or total of dicrotic wave, but undulatory character of whole down-line—indicate disease of the ascending aorta. Congestion of the left arm, supraclavicular region, and side of the head; aneurismal character of right pulse (radial and carotid); tumor symptoms a little to the right of the sternum, and probably some tracheal dyspnoea, are symptomatic of aorto-innominate aneurism. Modification of left radial pulse; affection of left vocal cord; left venous congestion; tracheal dyspnoea and obstruction of air to both lungs, with tumor symptoms on and to the left of the median line, mark disease of the transverse aorta. Obstruction to the entrance of air to the left lung alone, with pains at the back and along the intercostals, is indicative of disease of the third part of the arch.

It is unnecessary to multiply these examples, which must be taken as indicating simply the broader lines of diagnosis.

Treatment of Aneurisms of the Aortic Arch.—A certain number of patients suffering from aortic-arch aneurism have undoubtedly got well under treatment by rest and medicines. These cases, however, are but few; the great majority of these patients either receive no benefit or quickly relapse. Hence every such case should be sedulously watched, that failure of treatment may at once be recognized. Especially should the commencement of pressure on the air-tubes be carefully observed, because increasing dyspnoea is not only a sign that the aneurism is becoming larger, but shows that the rest treatment is no longer possible. There can be no repose for one who is now and again convulsed with violent cough, and whose every breath is labor. Moreover, as my late lamented friend, Dr. Pearson Irvine, conclusively showed, partial occlusion of the windpipe brings on a certain form of pulmonary disease, chiefly due to obstruction in the exit of air.¹ This disease of itself would destroy life, even if the aneurism could be cured. Therefore any considerable difficulty of breathing should be a strong inducement to operation, unless the circumstances be unfavorable.

We should, however, have clear rules for guidance as to which cases will, and which will not, benefit by such treatment. Furthermore, we have to discriminate between the suitability of two operations, namely, that on the left, and that on the right side of the neck. In order, therefore, to save space and time, I will put in the form of a summary the conditions which should guide us in our choice. It must, of course, be understood that only the principal, not the minuter points, can be thus summarized, and that in

¹ Pathological Transactions, vol. xxviii. p. 67.

their combination certain of the symptoms may, especially if early in the case, be wanting.

(1) *For Deligation of Left Carotid.*—Tumor symptoms upon and somewhat, but not far, to the left of middle line, and rising into episternal notch, or beneath left sterno-mastoid. Left venous congestion; alteration of left carotid, and to a much less degree of left radial pulse. Paralysis of left vocal cord; obstruction to entrance of air, equal on both sides of chest; sometimes alteration of left pupil.¹

(2) *For Deligation of Right Carotid and Subclavian.*—Tumor symptoms on right of median line. Marked changes in right radial and carotid pulse. Venous congestion on right side, affecting first and chiefly head and neck. Afterwards, with increase of tumor, right arm and chest, and right vocal cord, may be paralyzed.

Tumor symptoms on right of and upon mesial line, running up to sterno-clavicular joint and episternal notch; venous congestion on left side; alteration of right pulse (radial and carotid); tracheal dyspnœa.

Tumor further to the right, and lower (second space); congestion equal on both sides; no marked difference between the two pulses; heart displacement, chiefly outward.

Pressure on right bronchus; left lung perfectly free; with puerile respiration, and perhaps emphysema.

With any of these conditions, changes of the right pupil may be combined.

(3) *Doubtful Signs, only to be Read by the Light of other Symptoms.*—Venous congestion on the left side; tracheal dyspnœa; dysphagia.

(4) *Operation should be Avoided.*—When tumor symptoms reach widely on both sides of mesial line. When, with paralysis of left vocal cord, there is obstruction of right bronchus. When "locomotive" pulse, thrill, and double murmur, show considerable aortic incompetence. When there is mitral disease or considerable cardiac hypertrophy.² When there is, in the course of the aorta, the rasping sound of calcification or advanced atheroma, more particularly if the superficial vessels are felt to be rough and rigid. When there is pain about the spine and intercostal nerves; when there is obstruction of the left bronchus only; when there is pressure on the left apex, and expectoration of frothy blood. To these positive signs, I would add a negative one, viz., the symptoms being so indefinite as to render any diagnosis as to the site of the aneurism doubtful.

Results of Simultaneous Double Distal Ligature.—I have been restrained by considerations of space from giving, for the more usual deligations, the lists of operations, since tables of names, dates, results, etc., would in a work like this be inadmissible; but here, partly because the cases are comparatively few, partly to show the importance of the views which I have expressed concerning the conditions of the heart and aorta, the whole list, twenty-seven in number, shall be given in full. The first twenty-four cases were all of aneurism supposed to be innominate.

¹ I would carefully exclude such aneurisms as spring from the aorta beyond the orifice of the left carotid, as more likely to be injured than benefited by tying that vessel; whether any such cases could gain by deligation of the left subclavian, is doubtful, or has at all events not yet been proved.

² Aneurism of the aortic arch offers a certain resistance to the blood-stream, and thereby is rapidly productive of a certain cardiac hypertrophy. Unless this be severe, it need not negative operation if the valves be sound; a much smaller hypertrophy is deterrent if there be also aortic incompetence. Perhaps it will be well also to point out a circumstance which should induce us to insist strongly on operation, with as little delay as possible. Aneurisms of the ascending and cardiac part of the transverse aorta cause the mass of blood a little above the valves to be large in amount; hence it falls with undue force on the valves, which can be heard to close with violence—the door is slammed rather than shut. If this be allowed to go on, incompetence will soon be produced.

SIMULTANEOUS DOUBLE DISTAL LIGATURE.

No.	Surgeon.	Date.	Duration of life.	Termination.	Post-mortem appearances, and remarks.
<i>For Innominate Aneurism (as diagnosed).</i>					
1	Hobart, ¹	1839	16 days	Killed herself by throwing pillow at nurse.	
2	Rossi, ²	1839	6th day	.....	Left carotid artery was closed; patient's brain nourished by one vertebral.
3	Heath,	1865	4 yrs. 17 days	Aneurism practically cured.	It was of the ascending aorta.
4	Maunder,	1867	5 days	Aneurism filled with soft black clot.	Tumor to left of innominate; left carotid should have been tied.
5	Sands,	1868	13 mos.	Aneurism nearly full of laminated clot.	
6	Hodges,	1868	12 days	.....	Merely an aortic dilatation.
7	Holmes,	1871	55 days	No benefit.	Aorta much dilated.
8	Lane,	1871	52 days	No benefit.	No post-mortem examination.
9	McCarthy,	1872	15 days	Hemorrhage from proximal end of subclavian.	
10	Durham,	1872	6th day	Death from shock.	Probably in this case cardiac hypertrophy.
11	Green,	1874	3 mos.	Rupture of sac.	
12	Ensor,	1875	65 days	.....	Aorta much dilated.
13	King,	1876	111 days	Suppuration of sac.	Aorta much dilated.
14	Weir,	1876	15 days	Sac nearly full of laminated clot.	Aorta much dilated, atheromatous.
15	Eliot,	1876	26 days	Sac occluded by laminated clot.	Aorta very atheromatous.
16	Barwell,	1877	103 days	Aneurism cured (patient killed himself by exposure).	Bronchitis unconnected with aneurism.
17	Barwell,	1877	19 mos.	Aneurism cured.	Bronchitis, no connection with aneurism.
18	Barwell,	1877	30 hours	.....	Aorta dilated; heart hypertrophied.
19	Little,	1877	40 mos.	Aneurism cured.	Died from pleurisy, unconnected with aneurism.
20	Ransohoff,	1879	7 days	Aneurism lined by laminated clot.	Fusiform dilatation, arch of aorta atheromatous, with calcification.
21	Stimson,	1879	Still lives	.....
22	Palmer,	1879	125 days	Aneurism consolidated.	Pressure of solidified aneurism caused ulcer of innominate vein.
23	King,	1880	14 mos.	Aneurism cured.	Died from bronchitis; some aortic dilatation.
24	Pollock,	1880	10 days	Aneurism lined with laminated clot.	Aorta dilated, and with large patches of atheroma.
<i>For Aortic Aneurism (as diagnosed).</i>					
25	Barwell,	1879	15 mos.	Aneurism cured (ox aorta ligature).	Died from slow exhaustion and debility following dissipation.
26	Lediard,	1880	8½ mos.	Aneurism solid (ox aorta ligature).	
27	Wyeth,	1880	1 year.	Died from diarrhoea (ox aorta ligature).	Aneurism partly filled with clot death not due to aneurism.

[The editor has, in his chapter on aneurism,³ tabulated or referred to 48 cases of simultaneous, double, distal ligature, the aneurism in 34 cases having

¹ This is set down as a deligation of the first part of the subclavian. Mr. Holmes, who had an opportunity of examining the preparation, doubts if that vessel were tied.

² Some writers report Rossi's case as a deligation of the first, others as one of the third part of the subclavian.

³ Principles and Practice of Surgery, 4th ed., pp. 592 *et seq.* Six cases added since.

involved the innominate, and in 13 the aorta, while in 4 the aorta was dilated though not aneurismal; of the whole 48 cases, 21, or less than half, terminated fatally, while in 22 decided benefit, of greater or less duration, was experienced. A successful case operated on by the editor, and reported by Dr. Wharton, may be found in the *Transactions of the College of Physicians of Philadelphia*, 3rd Series, Vol. IX.]

It will be observed that in nearly all the cases of the above table which were followed by rapid death, the autopsy revealed disease of the heart, of the aorta, or of both. Therefore, the state of these parts should always be carefully investigated. In the present state of our knowledge, we may not always be able to diagnose atheroma of the aorta, or even a certain degree of dilatation; but it may often be inferred, though not absolutely made out. At all events, it is well to point out what conditions injuriously affect the death-rate of the operation, which should never be lightly undertaken without due knowledge of what to seek, and what circumstances should deter.

Consecutive double deligation has usually been employed in consequence of a hope that tying one of its branches would cure an innominate aneurism, the other branch being secured when, after a certain interval, improvement only, and not cure, has resulted. The operation may also, however, be undertaken because the surgeon, intending to tie both vessels, has reason, from the condition of the heart and aorta, to dread doing so simultaneously.

CONSECUTIVE DOUBLE DISTAL LIGATURE.

For Innominate Aneurism (as diagnosed).

Surgeon.	Carotid tied.	Subclavian tied.	Termination and post-mortem appearances.
Fearn,	Aug. 22, 1836	Aug. 30, 1836	Died of drunkenness, Nov. 27, 1838.
Wickham,	Sept. 25, 1839	Dec. 3, 1839	Died of rupture of sac, Dec. 15, 1839.
Malgaigue,	July, 1845	Oct. 17, 1845	Rupture of sac; erysipelas, Nov. 7, 1845.
Bickersteth,	May 11, 1864	June 17, 1864	No benefit; died of progressive disease, Sept. 1864.
Fleet Speir, {	Constricted,	Tied,	
Doughty and	May 4, 1874	Aug. 6, 1874	
A. B. Mori,	1875	June, 1876	Phthisis. Aneurism apparently cured, 1879.
Kuster, ¹	May 30, 1879	Aug. 15, 1879	Mitral incompetence; dilated aorta, Aug. 30, 1879.
Adams and	June 30, 1880	July 2, 1880	Hemorrhage from site of deligation.
Treves,			

The result of tying the *right carotid alone* for innominate aneurism is not to be considered satisfactory, and more especially is it unsuccessful if the disease involve the aorta. The vessel has been ligatured for *innominate*, or supposed aorto-innominate, disease, thirty times, with twenty deaths. But in cases of *aortic*, or aorto-innominate disease, the operation has been performed seven times, and in only one instance has it proved beneficial—the case of Mr. Annandale.² With this exception, the longest survival was forty-one hours; the next, nineteen hours; the others, ten hours and under. The conclusion to be drawn, is, that for low innominate aneurism, which almost always involves the aorta, it is safer to tie both vessels than the carotid alone.

Distal ligature of the right subclavian in its third part, for *innominate aneurism*, would not appear a hopeful procedure, since the carotid and so many

¹ The patient was greatly relieved of pain, and asked, if it returned, whether the surgeon could not tie some other artery; there were, however, other aneurisms, one of which seems to have burst. [Another successful case has been recorded by Mr. Beancy.]

² The patient survived two years; the cause of death is unknown, and there was no post-mortem examination. (Letter from Mr. Annandale.) I cannot persuade myself that the aneurism was aortic; the immediate effect of the ligature—stoppage of pulsation—must surely negative such an idea.

subclavian branches must allow a large stream through the artery. It has been done twice under the mistaken idea that the carotid was already obliterated (Wardrop, Broca), and once purposely (Bryant). All the patients survived some time, and appear to have been to a certain extent benefited. [Blackman's and Laugier's cases (the latter a deligation of the axillary) both proved fatal.]

For *aneurism of the aortic arch*, the *left carotid* has been tied eleven times; in the first few cases, the disease was supposed to be of the carotid,¹ but the operation has since been performed by others,² with the direct intention of benefiting an aortic aneurism. The four cases of mistaken diagnosis, and the first three of the intentional operations, did well. Pirogoff thus operated on a woman with aorto-innominate aneurism—not the procedure to be selected; Küster, on a man who had fusiform aneurism of the aorta and extreme cardiac hypertrophy.³ I have thus operated twice. My first patient was greatly improved, but died four months after of visceral disease. The next operation was undertaken at the desire of a physician, somewhat against my convictions; both carotid and subclavian were tied, as the aneurism extended far to the left. The man was rapidly approaching death when the vessels were tied, and I do not think that the end was either hastened or postponed.⁴ Mr. Heath has also operated twice; his second case was unfortunate, the patient dying very quickly from syncope.

Thus of the eleven cases, seven did remarkably well; four badly; probably all four—certainly two of them—were ill chosen.

[The editor has tabulated⁵ eighteen cases, including one of his own, of carotid ligation for aortic aneurism, more or less relief having been obtained in eight.]

ARTERIO-VENOUS ANEURISM.⁶

A few words must be said concerning a form of disease involving not only the arterial trunk, but also the neighboring vein, or an adjacent venous cavity, which indeed essentially consists of an interparietal communication between the area of the one and of the other.

In former times, when venesection was so frequently practised as often to be entrusted to unskilful hands, this disease was very common at the bend of the elbow, and indeed, since other external aneurisms were treated after one method, that of Antyllus, the ingenuity of the older surgeons was chiefly exercised upon this condition. Anel himself, whose name is still attached to one form of arterial deligation, first practised his method on an aneurism of this sort at the bend of the elbow (see p. 883). But as we shall see, the disease may be spontaneous, and is by no means confined to this situation, but may occur in any part of the body where an artery and a vein are in juxtaposition.⁷

The disease assumes two forms, viz., *aneurismal varix*, when the artery opens directly into the vein, the edges of the two holes being in contact, and adherent; and *varicose aneurism* when between the two vessels is interposed a distinct sac, into which they both open.

¹ Montgomery, O'Shaughnessy, Rigen, Tilanus. It was these cases that prompted Dr. Cockle's paper and suggestion; Heath was the first to carry it into effect.

² Heath, Holmes, Barwell, Pirogoff, and Küster.

³ Das Herz war ungemein gross.

⁴ Med.-Chir. Trans., vol. lxiv.

⁵ Op. cit., p. 591.

⁶ That form of arterio-venous disease which consists in an enlargement of the arterioles and venules—viz., aneurism by anastomosis or cirroid aneurism—has been described in the preceding article.

⁷ Usually, the communication is formed between vessels that are normally in contact; but even this is not essential.

ANEURISMAL VARIX.—The former of these maladies, nearly always traumatic, may probably best be described by taking as our type the formerly common arterio-venous puncture in venesection. “When this happens,” says W. Hunter,¹ the first who correctly described this condition, “the injury done to the artery is commonly known by the jerking impetuosity of the stream which flows from the vein, and by the difficulty of stopping it when a sufficient quantity has been drawn;” also, if what I saw long ago in a single case be usual, by the appearance of two colors in the blood. When, however, the hemorrhage has been checked by pressure, and the wound has healed, the opposed openings adhere to each other, and the vessels intercommunicate. The disease is then marked by dilatation of the punctured vein and its affluents, for two inches or rather less, above, and for rather more than that distance below, the cicatrix left by the puncture. The enlargement is well marked; its limits are somewhat abrupt; it pulsates rather less forcibly than an artery dilated to an equal size would do; and added to this, there is a continuous, vibratile thrill, best felt when the finger touches the part but very lightly. To an ear applied gently on the tumor, this thrill is translated into a rasping or snarling sound, which William Hunter² compares to “what is produced in the mouth by continuing the sound of the letter R in a whisper.” I would call it “thrill-murmur.” This vibration is, if the hole of communication be large, apparent even to sight; especially at a point opposite the arterial opening. The venous tumor can be readily emptied by pressure, but immediately fills again, not by afflux of blood from the veins below, but from the artery above, as may be proved by tying a fillet tightly round the arm just under the seat of disease. When the limb is raised vertically, the tumor diminishes, and if, while that posture is maintained, pressure be made on the artery above, all thrill and bruit cease, while the swelling almost entirely disappears. In some cases the point of the finger, by following as a clue the line of most marked vibration, may be made to impinge directly on the arterial opening, when vibration is checked, and the enlargement almost entirely subsides.

Occasionally the artery above is dilated and convoluted, pulsating more largely and strongly than natural, while nevertheless the artery below, and the radial pulse on that side, are smaller than on the other. The veins, for a little way above, and throughout the limb below, are enlarged, tortuous, and varicose, and for a certain distance may be seen, or by a very light touch may be felt, to pulsate very distinctly. Also, in most cases, the integuments of the forearm and their appendices, hair and nails, are hypertrophied, and sometimes the part, especially in the course of the veins, is peculiarly hirsute.

VARICOSE ANEURISM.—Varicose aneurism differs from the above-described condition by the interposition of a blood-containing cavity between the arterial and venous wound; the intercommunication of the vessels is, therefore, less direct, and hence a certain difference exists in the relative intensity of some of the symptoms above described, according to the indirectness of the obstruction, and the mode in which the two opposing streams meet within the aneurismal pouch. The veins, varicose both above and below, are not, as a rule, as largely distended immediately opposite the puncture, nor do they pulsate as distinctly and clearly, as in the other form of the disease. The aneurismal tumor is easily distinguishable; it pulsates and makes a peculiar noise, more or less loud and harsh according to the size, shape, and relative position of the openings. It is sometimes hissing or rasping, sometimes like the murmur of a spiral shell, the boiling of a kettle, or, as in a case which I

¹ Med. Observations and Inquiries, 1761, p. 34.

² Op. cit., p. 37.

saw in 1872, is like the noise of a gas-burner turned too high. It is sometimes loud enough to keep the patient awake, or even to waken him if he happen to raise up the affected arm near to his ear. The same mechanism which produces the sound causes a vibration of the tumor, which is exactly like the sensation communicated to a hand placed on the back of a growling dog, or a purring cat. This thrill is continuous, and may be felt through and with the pulsation, but neither increases nor decreases with the beat of the heart. The same condition of tegumentary hypertrophy exists as was described in speaking of aneurismal varix, and to this is not unfrequently added a general, soft thickening of the sort sometimes called solid œdema; ordinary œdema, also, is not unusual.

Other places where traumatism occasionally produces arterio-venous aneurism of the varix variety, are some parts of the scalp, mostly over the temporal, large auricular, and occipital arteries; but in those places, because the vessels are smaller, the anastomoses freer, and the surrounding tissues denser, a somewhat different result is produced, namely dilatation of the arterial and venous branches, their offsets and minute twigs, into a mesh of enlarged, convoluted, and pulsating vessels, closely resembling—indeed, generally indistinguishable from—cirsoid aneurism; a subject which has been considered in a previous article. Also, the disease has been known to follow fractures through the sella turcica or orbit, the preternatural communication being either between the carotid artery and cavernous sinus, or between the ophthalmic artery and vein, whence, as already described, originates one form of the disease termed pulsating tumor of the orbit.¹

It must not, however, be supposed that arterio-venous aneurism is always the result of wound. Varicose aneurism has often occurred without such causation, and in deep parts of the body; even aneurismal varix may thus arise without direct wound. I believe Mr. Syme² to have been the first surgeon who published a case of varicose aneurism of the aorta. Six years subsequently, viz., in 1837, Mr. G. H. Perry³ noted a case of this disease occurring between the popliteal artery and vein, and Mr. Porter⁴ recorded a similar example. In 1840, Mr. Thurnam⁵ read his excellent memoir on the subject; since which time, although additional cases have been published by Rokitsky,⁶ Mayn,⁷ Beaumont,⁸ Pemberton,⁹ Wade,¹⁰ and many others, little light has remained to be thrown upon the matter. This light chiefly touches certain points regarding the relative frequency of the disease at different parts, and the mode of its occurrence.

Mr. Thurnam's paper first called attention to the fact that these preternatural communications may take place between the largest vessels of the body—as between the first or second part of the thoracic aorta and any large vein or venous chamber of the heart. Thus there is distinct anatomical evidence of the existence of arterio-venous aneurisms of most of the larger vessels of the body. Thurnam's cases, indeed, show that of 18 aortic aneurisms,

¹ Delens, Thèse; De la communication de la Carotide interne et du Sinus caveux. Paris, 1870.

² Edinburgh Medical and Surgical Journal, July, 1831, p. 114.

³ Medico-Chirurgical Transactions, vol. xx. p. 31.

⁴ Cyclopædia of Anatomy and Physiology, vol. i. p. 242.

⁵ On Aneurisms, especially Spontaneous Varicose Aneurisms of the Ascending Aorta. Medico-Chirurgical Transactions, vol. xxiii. p. 323.

⁶ Ueber einige der wichtigsten Krankheiten der Arterien.

⁷ Dublin Medical Journal, July, 1854.

⁸ Medical Times and Gazette, 1867, vol. ii. The preparation is in the College of Surgeons' Museum.

⁹ Medico-Chirurgical Transactions, vol. xlv. p. 189. The disease followed pressure-treatment for popliteal aneurism.

¹⁰ Ibid., p. 211.

11 had formed communication with the pulmonary vein, 4 with a cavity of the heart, and 3 with one of the venæ cavæ.

Thus, on examining these records and collating them with others gathered by Sibson and by myself, we may construct the following table,¹ showing the relative frequency of these various conditions:—

No. of Cases.	Aneurismal Artery.	Communicating with
17	Ascending aorta.	Pulmonary artery.
6	“ “	Right auricle.
3	“ “	Right ventricle.
4	“ “	Descending vena cava.
3	“ “	Left ventricle.
2	Transverse aorta.	Descending vena cava.
7	Descending aorta.	Ascending vena cava.
5	Common carotid artery.	Internal jugular vein.
1	External “ “	“ “ “
4	Internal carotid “	Cavernous sinus.
2	External iliac artery.	External iliac vein.
3	Femoral artery.	Femoral vein.
2	Popliteal artery.	Popliteal vein.
1	Posterior tibial artery.	Posterior tibial vein.

In five of these sixty cases, the form of intercommunication was that of aneurismal varix; in the rest, that of varicose aneurism. The mode in which the disease is produced in the large internal vessels, and frequently in external parts, is as follows: First the artery develops an aneurism which, in the course of its growth, presses upon and ultimately opens into a vein or venous cavity, just as it might, if otherwise placed, have opened into a bronchus or the pharynx. Sometimes such a rupture is followed by rapid or immediate death. Of the patients whose cases are above tabulated, though one lived for only a very few hours after the event, the larger number survived for weeks or months, and one even for more than three and a half years.² That life could be thus compatible with so grave a lesion, would be, unless supported by ample evidence, incredible; yet, not only does clinical observation indicate this fact, but the smooth and rounded margin of the arterio-venous opening attests the long duration of patency. Indeed, in one case the condition diagnosed during life caused so little trouble that the man “declared he was quite well, except that his breathing was a little short; he could not be induced to remain longer in hospital, as he was determined to resume his employment.”³

The mode in which these openings form is the same as of any ruptures of aneurismal sacs into other adjacent cavities. The tumor in its increase presses on the walls of the venous space, causing adhesion, and then gradual thinning and absorption of the walls, until the sac bulges into the vein or cavity, and at this part—since an empty cavity or one with fluid contents offers less resistance than solid tissue—the wall is apt to further dilate and become thinner. The actual rupture may be aided by some sudden effort, or may be quite spontaneous; in the latter case it is more likely to be slower than in the former, but may be as sudden; and although one would suppose that sudden rupture must of necessity be more constantly and rapidly fatal than the more gradual breach, yet I do not find, as far as clinical symptoms permit the moment of the event to be fixed, that such difference really exists.

¹ I am, of course, aware that more cases are scattered, and especially of late years, in surgical journals, but it seems to me sufficient to take those which I have found recorded between 1840 and 1870.

² Case VIII. of Thurham. The communication was with the pulmonary artery.

³ Wade, loc. cit. The communication was at that time only with the pulmonary artery, the opening into which was, after death, found to be round, regular, and smooth; a further opening, ragged and thin-edged, was recent, and the immediate cause of death.

External arterio-venous aneurisms may form in the same way, or from an abscess opening into both vessels; but this mode of origin is undoubtedly less frequent than some form of traumatism,¹ and especially common are, first, venesection wounds, and then gunshot injuries. Bardeleben collected from published sources 91 cases of traumatic arterio-venous aneurism. Of these 49 were from venesection, 14 from gunshot wound, and the rest from various forms of injury; therefore, as might be supposed, the greater number of cases depend upon preternatural communication between the brachial artery and the median basilic vein. The next most frequent seat of the disease is between the femoral artery and its vein (13 cases), the next in the temporal artery (9 cases),² etc.

Nor are we to suppose that the disease follows, of necessity, immediately or rapidly after infliction of the injury. In Rokitansky's case,³ the disease first made its presence known in the axilla thirty years after the receipt of a gunshot wound. Beaumont's (Toronto) patient had received a wound in the groin; for more than ten years a loud and constant thrill-murmur, audible at some distance, was the only symptom; at the end of that time an aneurism formed while riding on horseback.⁴ In Dr. Cotter's case, a wound of the thigh occurred eight and a half years previous to the formation in the scar of an aneurismal varix.⁵

That comparatively small vessels may be thus affected, is shown by the relatively not infrequent occurrence of a communication between the temporal artery and its companion vein; this has been generally due to arteriotomy practised for therapeutic purposes, but it has also followed an accidental wound. But perhaps the most interesting example of such disease in a very small vessel is the case reported by Mr. Moore.⁶ The disease was developed on a branch of the sciatic artery within the substance of the popliteal nerve; therefore, though the tumor was not large, and communicated with very small vessels, it gave great pain, and caused considerable embarrassment in diagnosis. It is not mentioned, whether or no, in this case, auscultation was employed. The case is described as one of arterio-venous cyst.

Diagnosis of Arterio-Venous Aneurism.—The diagnosis of this disease, in those parts of the body which interest us as surgeons, depends upon the points of symptomatology and history already described. A direct wound in the course of an artery, followed by pulsation of enlarged and varicose veins; a tumor at or near the site of injury; and a murmur more or less loud and harsh, present the problem in its simplest and easiest form. When the vessel is superficial, as at the bend of the elbow, or near the groin, the distinctive differences between aneurismal varix and varicose aneurism can be readily made out. Certain symptoms may, it is true, either by their presence or absence, cause some doubts; but the peculiar purring, or thrill-murmur, is, when present, so characteristic, that, even if there be no tumor, the existence of arterio-venous communication may be taken as established.

More deeply seated disease, especially if it be surrounded and compressed by firm, strong muscles, occasionally, though rarely, omits the most significant symptom—murmur⁷—or, at least, that phenomenon may be but slightly marked.

¹ Pressure, as in Pemberton's case already mentioned, may be classed as a traumatic cause, although the mechanical injury be slow (chronic) in its mode of action.

² Bardeleben, Diss. Inaug., Berlin. Ueber das traumatische Aneurysma arterio-venosum.

³ Ueber einige der wichtigsten Krankheiten der Arterien.

⁴ Med. Times and Gazette, July 27, 1867.

⁵ American Journal of the Medical Sciences, vol. xlviii. p. 36.

⁶ Med.-Chir. Transactions, vol. xlix. p. 29.

⁷ See a case by Mr. Annandale, Lancet, April 24, 1875. The disease was in the posterior tibial artery and companion vein, and was, until operated on, mistaken for a common aneurism.

On the other hand, if the vessel be one of the smaller branches of the scalp, dilatation of its offsets and of all inosculating twigs may cause the disease to assume the characters of cirroid aneurism rather than that of direct communication, though in nearly all such cases the thrill-murmur is quantitatively different from the slight, rustling bruit of ordinary, large aneuriomata. Again, from the cases already quoted, it is evident that murmur may, for a time, be the only symptom of the disease, which must surely have been present, though inactive, during the ten and the eight and a half years of abeyance of Beaumont's and Cotter's cases.

Treatment of Arterio-Venous Aneurism.—The treatment of this condition must be on the lines, slightly modified, of that of common, sacculated aneurism, but certain of the methods applicable to that affection are, as a rule, useless in this complicated form of the disease. Moreover, certain differences exist as to the management of the varicose and varix varieties.

In *varicose aneurism*, treatment is always necessary, while many cases of aneurismal varix, especially of the upper extremity, producing no pain, and not leading to rupture and hemorrhage, may be left untreated, or be simply met with palliative measures. Fortunately, also, varicose aneurism is somewhat more amenable than the other form to non-operative measures, namely, to the various forms of *pressure*. The presence of a sac in these cases is the point of vantage accorded to that form of treatment, and, indeed, it is probable that Reid's method—the elastic bandage being applied both below and above, but not over, the tumor—would be that most adapted to the exigencies of the case.¹ In the event of that mode of treatment failing, direct and indirect pressure should be given a full and fair trial, and in most cases it will be better to alternate these methods, according to the pain produced and the susceptibility of the patient. Even if the aneurism itself be not cured by these means, it may, perhaps, be converted into a simple aneurism by closure of the venous opening. Nélaton² records four cases in which this transformation took place, but it is somewhat singular that no such change has occurred in the practice of any other surgeon; Nélaton's patients were, it appears, afterwards cured, some by indirect pressure, some by the Hunterian ligature.

Injection of perchloride of iron has been employed, and in two cases with success—once, namely, by coagulation, and once by suppuration of the sac.³ When, however, the precautions which must be taken during the treatment of simple aneurism by this method are considered, it certainly seems to me that the double communication of the sac of a varicose aneurism must render still more pressing the danger of embolism, unless, indeed, the blood in the whole limb be entirely immobilized for an unusually long time. The same remark may apply to *galvano-puncture*; yet three cases, two quoted by Cini-selli and one recorded by Debout, are said to have been thus cured.

The *ligature* for varicose aneurism is not to be lightly employed, but is most certainly justifiable when the tumor is increasing quickly enough to render rupture a mere question of time, or when pressure on other veins, besides that immediately implicated, renders gangrene a more probable result of delay than of interference. Cases, moreover, in which expectant or temporizing treatment can be adopted, are rare, though less so in the upper than in the lower limb. The Hunterian deligation must be rejected; it almost

¹ I have not myself had, since the introduction of this method, any opportunity of treating a varicose aneurism, nor can I find any record of a case so treated; the above opinion must, therefore, be taken as formed on *a priori* grounds only.

² Journal de Médecine et de Chirurgie pratiques, 2e s., t. xxxiii. p. 155.

³ Jobert (de Lamballe), Bulletin de l'Académie de Médecine, 1854; Vallette, *ibid.*, 1859.

always fails to cure, though a few cases are on record in which it produced a certain benefit¹ by delaying the progress of the malady. The form of deligation should be after the method of Antyllus, that is, immediately above and below the site of disease. Generally, in such cases, it will be necessary to open the sac and turn out any clots, little in quantity and loose in texture as they are in this form of aneurism; or, when feasible, greater safety may be insured by tying the vessel above and below, while leaving the sac intact. But certain difficulties attend this operation; if the vessel be not very deep, the upper part of the artery is reached with ease; but that part which lies below the tumor—contracted and often very small, surrounded also by swollen and tortuous veins—can with difficulty be found, and perhaps can only be taken up by tearing or cutting through many of those vessels. Herein lies one, perhaps the chief, danger of ligature for varicose aneurism, namely, the interference with and probable ligature of the main veins, which, in a limb already weakened and predisposed to sphacelus by the varicose condition of those vessels, may lead to rapid gangrene, especially if the disease be of the lower extremity. Hence in some cases, more particularly in old or enfeebled persons, the safer and more prudent course will be to amputate, rather than to incur the risk of producing an inevitable and perhaps irrestrainable gangrene.

The treatment of *aneurismal varix* should also be commenced by *pressure*, but direct pressure, not merely on the tumor, but also upon the foramen of communication, is that which is most likely to prove successful. Moreover, the finger has proved of all compressing instruments the most efficacious; yet it is only right to observe that in a large number of cases the treatment ends in disappointment. Nor does it seem desirable to continue it for any lengthened period unless palpable improvement gives encouragement to further effort. The Esmarch bandage and cord, if care be taken to keep the vessels at the site of disease full, also seem likely to be of avail.

If this simpler treatment fail, the circumstances of the case must be well considered before recommending any more severe measures. Frequently, and more especially in the upper limb, an aneurismal varix, having culminated in a certain enlargement of the vein about the site of disease, and in a certain varicose condition of the veins lower down, together with some weakness or facile fatigue of the part, proceeds no further, and remains stationary for years. In such circumstances, prudence would counsel both surgeon and patient not to employ, for a malady which involves so little inconvenience, any treatment that might endanger either life or limb. When, however, the troubles become, or in other cases are *ab initio*, more severe, and especially if they are increasing, surgical interference becomes not merely justifiable but imperative. *Galvano-puncture* and the *injection of coagulants* are not likely to prove of any avail.² There is no sac to the aneurism, but merely two tubes, one being more or less dilated; hence blood loosely coagulated by either method would probably be washed onward and cause embolism, as soon as the restraining pressure was removed. Both methods are probably more dangerous than in sacculated aneurism.

More safe is *deligation* with a properly selected ligature. The vessel should

¹ See case by Czerny (Archiv für pathologische Anatomie und Physiologie, Bd. 62, S. 464); the disease was femoral; the Hunterian ligature produced a certain temporary benefit. Also one by Ambrogio Gherini, who tied with slight transitory benefit the brachial artery at the junction of its middle and lower thirds, for varicose aneurism following venesection at the bend of the elbow (Annali Univers. di Med., Novembre, 1873).

² The latter mode of treatment has been recommended by a high authority as likely to be useful; but the opinion is not founded on any practical experience. (Holmes's System of Surgery, vol. iii. p. 531.)

be tied above and below the place of opening. The vein—especially if an important one, as the femoral at the groin—ought to be spared, though sometimes it is so adherent to the artery as to be barely separable;¹ yet to tie it would be very likely to induce gangrene. I would strongly advise very careful and patient attempts at separation to be made. It is below rather than above the opening that the difficulty occurs, and at the same time the artery is here so diminished in size that it is not easily found. Under these circumstances, and unless the diseased spot be immediately above a large branch, it may be well to relinquish the attempt to tie the artery below the mouth of intercommunication, and to elevate the limb. Blood from the vein could not, under such circumstances, flow along the artery, and in the absence of any arterial branch very near to the spot, return blood from the artery could hardly get into the vein. The Hunterian mode of deligation, whenever it has been tried under these circumstances, has, as far as I can find, invariably failed.

APPENDIX.

Although this article was finished some time ago, it appears to me desirable to render it complete by inserting a case of deligation of the innominate artery, recently performed by Mr. William Thomson, of Dublin. I do this with the more pleasure since the case, although terminating fatally, proves that my views concerning the action and importance of a flat ligature are correct. It also illustrates the value of the needle depicted at p. 926, which was devised by me for facilitating the passage of a ligature under the subclavian and innominate. As will be seen on perusal of the case, the operation could hardly have been completed without its aid.

In March of the present year (1882) Mr. Thomson wrote to me, describing a case of right subclavian aneurism which was under his care, and saying that he proposed tying either the subclavian in its first part, or the innominate. He asked me for a piece of my ox-aorta ligature. I replied immediately by sending what he had requested, and my needle. As the patient dallied a good deal, sometimes accepting, sometimes declining Mr. Thomson's proposal, that gentleman returned the instrument, believing that the patient would not submit to an operation. However, at the beginning of June, I again heard from Mr. Thomson, and in pursuance of his request once more sent him the needle. He had preserved the ox-aorta ligature forwarded to him in March. The patient having finally determined to undergo the necessary treatment, I am able, by the great courtesy of Mr. Thomson, to give the details of the case in that eminent surgeon's own words:—

John Murphy, aged 49, a locksmith, was admitted to the Richmond Surgical Hospital, Dublin, on the 7th of February, 1882, suffering from aneurism of the right subclavian artery. He was a man of medium development, healthy looking, and of dark complexion. His hair was grizzled. He had never had syphilis, had lived a fairly temperate life, and had been for eighteen months in America, where, in the war with the Confederate States, he had received a bayonet wound over the right scapula. For two years and a half he had been suffering from pains in the right arm, which he thought were due to rheumatism; but ten months before his admission he first noticed a small tumor, "about as large as a marble," in the posterior inferior triangle of the

¹ When treating of deligation of the femoral artery, I pointed out that occasionally the femoral vein, or a vein close to it, had in this operation been wounded, and yet that when the artery had been tied, bleeding had ceased. If in endeavoring to isolate the artery venous bleeding from the enlarged vein should occur, I would recommend that this should not be immediately ligatured. When the artery has been secured, the effect of thus checking the flow of blood to the part, and of raising the limb above the level of the pelvis, should be tried.

neck. He had sought advice at another dispensary, and at our own, but he had refused to come into hospital until he found that the tumor was steadily progressing, and that in addition to increase of pain he was now unable to work. The tumor, as it now presented itself, was globular and about two and a half inches in diameter, pulsating violently, with evidently very thin walls. It occupied the posterior inferior triangle, its inner margin being close against the outer edge of the sterno-mastoid muscle. The finger, passed behind the muscle, received a very strong impulse, and the vessel, as far as it could thus be traced towards its second part, appeared to be enlarged. The pulse varied from 130 to 140, and was very full. No pulse could, as a rule, be felt in the right radial artery, but occasionally it could be made out as a faint flicker. The arm could not be raised from the side; the pain in the shoulder was unbearable, and the patient lay in bed with his left hand grasping that part tightly, as he said that doing so gave him some relief. The heart sounds were healthy; the pupils were regular; there was no cough and no laryngeal irritation. The other functions of the body were natural.

The patient was kept under observation for a week, being at the same time treated with tincture of digitalis, but without any impression being made upon the rapidity of the pulse. I then had a consultation with my colleagues, Mr. Stokes, Mr. Thornley Stoker, and Mr. Corley, and I also had the advantage of the assistance of Dr. Robert McDonnell and Dr. Bennet, Professor of Surgery in the University of Dublin. The majority of opinion was in favor of attempting an operation upon the first part of the sub-clavian, and, in the event of that proving diseased, upon the innominate. I put the case before the patient, who consented to the proposal; but after an interview with his son, he declined it. He remained, however, in hospital, and I then tried for some time the iodide of potassium treatment, but without any appreciable result. The pulse still continued high, and the tumor increased in size, while the pain in the arm was combated by frequent hypodermic injections of morphia. The patient suddenly took his discharge on the 30th of March, as he said he had "private business" to transact. He once visited me at my house some weeks afterwards. The tumor had then grown to a considerable size, passing upwards in the neck; the pain kept him from sleeping, for he now had no hypodermic injections. There was no pulsation to be felt in the radial or brachial arteries. He promised to come into hospital next day, but he did not return until the 22d of May. He now stated that during the preceding night the tumor had ceased to pulsate for over an hour. When I saw him, pulsation was as violent as ever; all the local symptoms were aggravated, but the pulse had fallen to 100. Measured by the callipers, the tumor now marked three and one-fourth inches in diameter in all directions. A further consultation was held, and ligature was again determined upon; but on the 29th, the day but one fixed for operation, I was sent for to see the patient. All pulsation had stopped in the aneurism, which was now hard and tense. I resolved therefore to postpone any operative interference. The pulsation returned after about ten hours, and next morning was as bad as before. He had now three minim doses of tincture of aconite every three hours, but the pulse was not affected. On the 31st, pulsation stopped for fifteen minutes, but then recurred, accompanied with great pain. He was now ordered three minim doses of tincture of aconite every hour for twelve hours, the effect to be watched. The pulse-rate, which had been 116, fell to 96; but next morning the pulse was full and bounding at 100. On the 4th of June, the patient said that the tumor had ceased to beat several times, but this was not verified by the resident pupil; the pulsation was, however, feeble. During all this time, in which I had the benefit of daily conference with my colleagues, the tumor continued to grow in size until it reached three and a half inches in diameter at the base. The movement of pulsation was observed over a large area. When the patient sat up, the shoulder and the whole scapular region rose and fell with each pulsation of the aneurism. The hope which we had entertained of spontaneous cure did not appear likely to be fulfilled, and, in face of the fact that the disease was progressing, we unanimously agreed that operation should no longer be delayed.

Accordingly, on June 9, when I was favored by the presence of many eminent surgeons, the patient was brought into the operating theatre, and placed in the usual position on his back, with the head thrown well towards the left side, and deeply anæsthetized. I

made a free incision along his clavicle, from the anterior margin of the sterno-mastoid outwards, and joined its inner extremity by an incision along the anterior border of the same muscle. The clavicular attachment of the muscle was divided and turned up, and then the sterno-mastoid and sterno-thyroid were cut, to uncover the carotid, carefully avoiding the branches of the omo-hyoidean plexus, which could be seen. The vessel was of very large size, so much so indeed that some of those present thought I had arrived at the innominate. This belief was encouraged by the fact that at first, pressure upon it with the finger stopped pulsation in the carotid higher up, and also in the tumor; but this did not always occur, and was evidently the result of pressure on the subclavian communicated from a distance. I now went further down in search of the bifurcation; but this was an extremely tedious and anxious proceeding, and I was compelled to divide nearly the whole of the sternal attachment of the sterno-mastoid. Coming at last upon the origins of the subclavian and the carotid, at what appeared to be an alarming depth, the difficulty of reaching the innominate beyond was increased by the sky becoming obscured by a heavy thunder-cloud, which seemed to shut out all the top light. A mirror was then used to throw light into the wound, but without much good result, and I was here much delayed. The sheath of the innominate was at last slowly scraped through, and using an ordinary aneurism needle for this purpose, I succeeded in passing it under the vessel, which appeared to be healthy. I then determined to thread it with ordinary silk, and to use this to draw back the tape ligature which Mr. Barwell had been good enough to send me. But failing in this, as the opening between the sheath and the vessel was too small, I withdrew all, and threading a special needle, invented by Mr. Barwell, with the curved portion movable by a lever, I introduced this with comparative ease. I then, before tying, tested the effect of pressure upon the vessel, between my finger and the tape; lifting the vessel freely from its bed, and finding that all movement ceased in the aneurism, and in the carotid, I secured the ligature with three knots, drawing the ends with moderate firmness. The edges of the wound were brought together, and a drainage tube having been introduced into the lower part, an antiseptic dressing was applied, and fixed by means of an elastic roller. The arm and shoulder were also swathed in sheets of wadding which had been previously heated. The patient was at once carried to bed, and I saw him again in half an hour. The right side of the face was cold, but the pupils were equal. He had not fully recovered from the effects of the ether, but I noticed that when he attempted to ask me some questions, he always broke down in the middle of the sentence, and then seemed to be trying to recollect what he wished to say. This was the only symptom of brain disturbance that ever presented itself, and in the evening he seemed to have his mental faculties perfectly unimpaired. He was ordered ice, milk and soda-water, and beef tea. Two hours after the operation, the patient complained of pain in the shoulder, and had one-third of a grain of morphia hypodermically, repeated in two hours. Slept for three hours during the evening. Evening temperature 100.6° Fahr. right side, 99.4° left; pulse 136. At 11 o'clock, 99.6° right side, 99° left; pulse 120. No pain.

10th (2d day). At 3 o'clock this morning the patient was seen by Mr. Kidd, house-surgeon. Complained of pain over region of the stomach, and was given a hypodermic injection of morphia. Slept for several hours. In the morning I saw the patient; his stomach was much distended with flatus; ordered turpentine stipes and a carminative. Temperature at 8.30, 99° on both sides; pulse 120. The abdominal symptoms were relieved. At 3.30 respirations were shallow and rapid—44. No pain. Finding that the temperature was then only 99°, and believing that the dyspnoea was caused by compression, I loosened the elastic bandage and the dressings, which gave much relief. Evening temperature 99.8° on both sides; pulse 132. Diet as before.

11th. About midnight, severe pain in right shoulder; pulse 148. Relieved by morphia. Passed a very good night. Morning temperature 99.4°; pulse 128; respiration normal. Wound dressed under spray. Slight serous discharge. Edges uniting. Drainage tube cleansed. Much pain in arm after dressing. Hypodermic injection of one-third of a grain of morphia. Slept nearly all day. Evening temperature 100.4°; pulse 128.

12th. Morning temperature 99°; pulse 120. Passed a good night. Looking remarkably well to day. No radial or temporal pulse. Carotid still. Tumor decidedly smaller, the wrinkles beginning to return in the hitherto tense skin. No pain until

evening, when there was a slight recurrence of it in the right arm. Evening temperature 98.8° ; pulse 124.

13th. Morning temperature 99° ; pulse 120. During early part of night complained of difficulty of breathing, and pain on swallowing, but afterwards passed a good night, sleeping soundly. Wound healed save at the drainage opening. Tube cleansed and returned. Slight serous discharge. Evening temperature 98.6° ; pulse 124.

15th. Morning temperature 98.6° ; pulse 108. Wound looking well and firmly closed up to the drainage tube, which was removed and replaced by a few strands of catgut. Patient a good deal troubled with tenesmus; enema did not give relief, and he was ordered a mild saline aperient, which was effective; bowels moved twice. Evening temperature 98.4° ; pulse 116.

16th. Morning temperature 98.4° ; pulse 132. Mixture of tincture of digitalis in 5 minim doses, and sulphate of quinia in 2 grain doses, every fourth hour. Evening temperature 98.4° ; pulse 116.

17th. Morning temperature 98.4° ; pulse 120. Wound dressed. Some healthy pus escaped from sinus. Can feel when the right hand is pinched. Very quiet day. Evening temperature 98.6° ; pulse 104.

18th. Morning temperature 98.4° ; pulse 100. Wound dressed with boracic lint. Patient only complains of being tired from keeping in one position. Expresses himself as being otherwise well. Evening temperature 98.4° ; pulse 108.

19th. Morning temperature 98.4° ; pulse 104. Wound syringed with carbolic lotion, 1 in 40. Only about a teaspoonful can be injected before it returns. The discharge seems to come from above the apex of flap. Evening temperature 98.8° ; pulse 108.

20th. Morning temperature 98.8° ; pulse 104. Pus small in quantity, quite healthy. Temperature, which has been normal for seven days, rose to 99.6° this evening. He had a good deal of stinging, burning pain in the hand this afternoon. Tumor measured in one diameter $2\frac{1}{2}$ and in the other $2\frac{7}{8}$ inches—showing an altered form, and giving a reduction of one inch in one direction, and of half an inch in the other. Evening temperature 99.6° ; pulse 108.

21st. Morning temperature 98.6° ; pulse 100. Passed a very quiet night. Sensation good in the arm, but still very imperfect in forearm. Still no radial or temporal pulse. Temperature of arm very good. Swallowing again very painful. Evening temperature 99.6° ; pulse 100.

23d. Morning temperature 98.2° ; pulse 100. Pain in right eyeball, and occipital headache. Ordered 20 grains of bromide of potassium, which had the effect of relieving him. Pulse fell to 96 in an hour and a half. Pain in right hand, as before, for a short time. In the evening pulse rose to 116, and temperature to 101° . As there was no apparent cause for this, I was sent for, and saw the patient with Mr. Corley. The wound was examined, but nothing could be found there to account for the increased fever. Ordered 20 grains of bromide of potassium, and ice. Deglutition not as difficult as yesterday.

24th. Morning temperature 98.4° ; pulse 108. Passed a good night. Had a purgative. Pain in right hand and arm at intervals during the day. Wound healthy. Ordered $1\frac{1}{2}$ grains of quinia in pill, and a mixture containing 20 grains of bromide of potassium, and $1\frac{1}{2}$ fluidrachms of infusion of digitalis three times a day. Pulse and temperature at night again increased. Pain in hand very severe. Had hypodermic injection of morphia. Evening temperature 101° ; pulse 128.

25th. Morning temperature 98.8° ; pulse 108. Pain in head and eye returned. Temperature almost normal during the day, but again increased at night to 101° , after a severe attack of pain in the hand. Pulse 116 in the evening.

26th. Morning temperature 98.4° ; pulse 116. Patient rather depressed this morning, for the first time since the operation. Sinus syringed out with carbolic acid, 1 in 40. A piece of ligature, about two lines long by a line broad, with some shreddy substance, was washed out. This, on subsequent examination under the microscope by Mr. P. S. Abraham, proved to be yellow elastic tissue. Presumably it was one of the cut ends beyond the knot, as it was sharply defined, and under the microscope, at one part, the fibres were suddenly turned upon themselves, as if forming part of the knot. Evening temperature 99.8° ; pulse 120.

27th. Morning temperature 98.8° ; pulse 100. Patient looks very well and passed

a very good night. Sinus surrounded with granulations. No pain in hand until towards evening, when it became severe. Temperature taken on both sides, when it was found to be 101.4° in the right axilla, and 100.4° in the left. Complained of heat in the right arm. Had a hypodermic injection, after which he slept for two hours, and awoke free from pain. Temperature again taken—right axilla, 99.6° , left 98.8° .

28th. Morning temperature 98.4° ; pulse 104. Passed a good night. Swallowing easy. About half a drachm of pus escaped from sinus. Some shreds of yellow elastic tissue washed out. Pain in the arm again, followed by rise in temperature—right 100° , left 99.4° . Had a purgative mixture as before.

July 2 (24th day). Opening of sinus the size of a pin-hole. A few drops of pus escaped. Temp.: right 99.4° , left 99° .

July 4 (26th day). Sinus closed; pain in hand recurred as before.

July 6 (28th day). Sinus opened, and half a drachm of pus pressed out. Temperature rose to 100° in the evening.

July 8 (30th day). Pulsation visible at apex of flap, coming from portion of the innominate. Passed a very good day. At 11.15 P. M., patient noticed that he was bleeding. Hemorrhage had stopped when he was seen by the house-surgeon. Mr. Stokes and Mr. Thornley Stoker saw the patient with me soon afterwards. Wound examined; no bleeding. Dressing renewed with a shot-bag over all. Amount of blood lost about three ounces. Hypodermic injection of morphia. Ice.

July 9 (31st day). Passed a good day. No bleeding. Ergot ordered. Morning temp. 98.6° , pulse 100; evening temp. 100.4° , pulse 104.

July 10 (32d day). Very quiet day. $\frac{1}{120}$ gr. of atropia every fourth hour. Small quantity of pus.

July 11 (33d day). Some minute sloughs discharged on syringing.

July 14 (36th day). Says he is very well. Morning temp. 98.6° , evening 100° . Sulphide of calcium gr. $\frac{1}{4}$ three times a day.

July 16 (38th day). Patient says he has not felt so well since the operation. Morning temp. 98.2° , pulse 96; evening temp. 100° , pulse 104. A few drops of pus.

July 17 (39th day). At half-past three this morning a terrific hemorrhage took place. The clothes were saturated, and the blood ran in a large stream on the floor. The patient was greatly blanched and collapsed. Mr. Kidd gave a hypodermic injection of ether. Cold, clammy sweat, flickering pulse, voice a mere whisper. Patient did not lose consciousness, but said he could not see. When I saw the patient, bleeding had stopped. The patient had then rallied somewhat, and complained of pains in his head and limbs. Increased pressure was made with shot-bags, the dressings not being disturbed. Warm jars placed to feet and body. Further stimulation prohibited. Ice and beef-tea in small quantities.

July 18 (40th day). No bleeding. Seen with me by my colleagues, and by Dr. R. McDonnell and Professor Bennett. Very weak. Treatment as before. Pain in limbs treated with morphia.

July 19 (41st day). Has rallied considerably. His expression is much improved. Color has returned to his face, and his pulse is stronger, but jerky. Pain in limbs. As patient's bedding had not been disturbed since the hemorrhage, he was carefully lifted by seven persons, and a clean mattress, etc., substituted.

July 20 (42d day). Complained of difficulty of breathing at 2 A. M., and much pain. Had half a grain of morphia subcutaneously. Slept for some time, and died quietly at 8.15 A. M. There was no recurrence of bleeding.

Post-mortem Examination.—An autopsy was held a few hours after death, but as any interference had been forbidden by the patient's son, a partial examination only could be made. Only the parts actually involved in the disease and the operation could be removed.

A small opening in the skin was the only part that appeared unhealed. The rest of the incisions were firmly cicatrized. The size of the tumor was $2\frac{1}{2}$ by $2\frac{1}{2}$ inches. When the skin was reflected, there was no trace of infiltration of parts, and no sign of blood. The opening in the skin led into a small cavity containing about a drachm of pus. When this was removed, the cavity was found to be about three-quarters of an inch in depth, above and slightly behind the right sterno-clavicular articulation, point-

ing downwards, backwards, and inwards. It received the end of the little finger, like a thimble. The tumor itself was covered by skin and platysma, and some outer fibres of the sterno-mastoid muscle; the omo-hyoid was stretched across it. The phrenic nerve passed along the inner side, borne off by the anterior scalenus; the muscle was bulged forwards, but the nerve did not seem to be pressed upon. Across the whole surface of the tumor were, lightly stretched and flattened, large roots and branches of the brachial plexus. In the anterior inferior triangle the tissues overlying the great vessels were so matted together that they could only be dissected with difficulty, especially at the lower part of the carotid. The internal jugular was collapsed. The common carotid was full and firm to the touch as far as the bifurcation. The subclavian vein was empty, and was tightly stretched along the lower and anterior part of the tumor. Its coats were thin, and in two places, near the junction of the internal jugular, there were small translucent patches, apparently from thinning of the internal coat. A few drops of pus oozed out of the lower end of the carotid, into the ulcer which terminated the sinus. On turning forward the anterior scalenus, the aneurism was found to involve the second part of the artery. The tumor was found to rest upon the first rib, and to press against the clavicle in front. These bones were removed; the rib with its attachment to the aneurism, and as much of the aorta as could be reached, were cut across; and the parts were taken out *en masse*.

The tumor was found to spring from the posterior part of the second and third portions of the subclavian artery. It was flattened below, where it rested on the rib, and passed upwards for three inches, ending in a dome-like surface. Corresponding to the clavicle, it was constricted. Its clavicular portion measured two and one-eighth inches antero-posteriorly; its basal portion, two and three-quarters. The artery was elsewhere normal in size. It formed a cord from which the tumor sprang. The axillary portion, as far as it could be removed, was firmly plugged. All the vessels of the first portion were traced, and were pervious.

The ulceration, which was somewhat larger than a sixpence in area, was situated at the bifurcation of the innominate into the subclavian and carotid arteries. It involved the anterior portion of the walls, and, looking into it, the clots blocking the three vessels could be seen. The surface was gray and shreddy; there was no staining of blood visible; the vessels were partly slit, and a syringe was used to force water through them in the direction of the circulation, but although this was carefully tried with each vessel, not a drop passed through. The incisions were extended along the vessels towards the ulcer.

The wall of the innominate was thickened almost from its origin, and this thickening increased gradually as the site of the ligature was approached, until the depth was about two lines. The clot was firmly adherent to the walls, and extended backwards through the greater extent of the vessel. At its cardiac side was a tongue of organized clot, rather loosely attached, and between it and the firmly adherent clot were some retiform bands of fibrous tissue deeply stained with blood.

The subclavian was found to be empty, except at its cardiac end, which was well blocked with a firmly adherent clot. This projected towards the aneurism for about half an inch. No water could be forced through.

The common carotid felt solid, but on opening it, it was found that the centre of the clot had degenerated, and was occupied by pulpy, purulent material. The walls of the vessel were thickened; the clot terminated near the bifurcation into the external and internal carotids. The aorta was thickened, atheromatous, and in patches calcareous. The lung and pleura, as seen on the right side, were healthy.

An incision was made into the aneurism from summit to base; it contained about half an ounce of dark, thick blood, and in the centre was some passive clot occupying a cavity about the size of a walnut. The process of cure was evidenced by fibrinous layers upon the walls to the extent of a third of an inch, and on the inner sides of this coating were masses of coagulum, less firm, but evidently undergoing consolidation.

A prolonged and careful search was made for traces of the ligature, but none could be found. On the posterior surface of the innominate, opposite the ulceration, was some fatty tissue, intimately adherent to the wall, which could with difficulty be cleaned.

A more minute examination of the parts was subsequently made. The vessels were all divided into the ulcer. This showed that the innominate had been constricted at

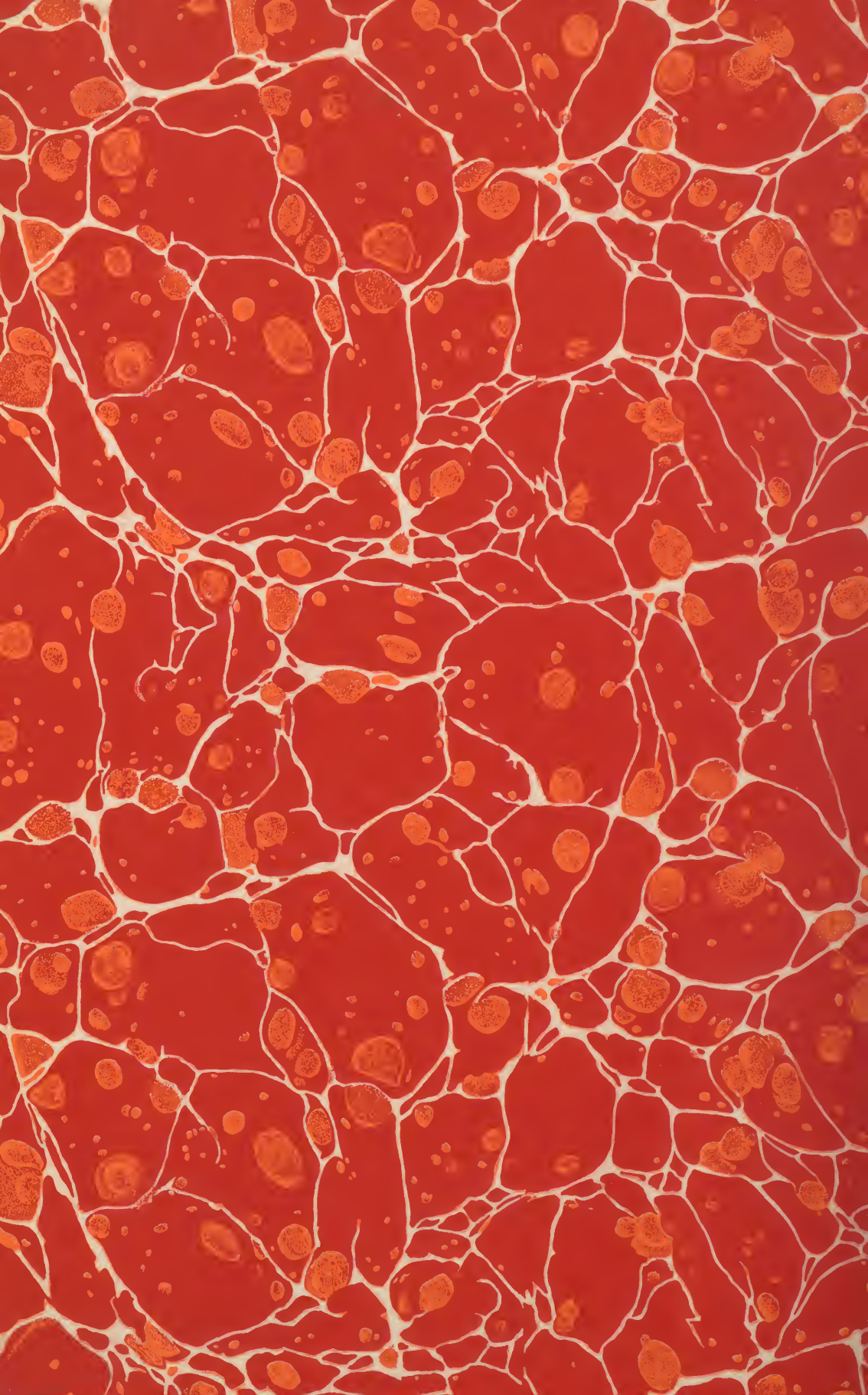
about a quarter of an inch from the cardiac margin of the ulcer. The walls were not divided, and the ulcer had not taken origin at the site of the ligature. The vessel was not occluded by adhesion of the inner surfaces, but a chink remained at the ligatured portion, through which the clot was continued, and had been united to the clots in the subclavian and the carotid. The clot in the subclavian was well formed. The ulcer had eaten into the innominate at its centre, and had in this way doubtless caused the hemorrhage.

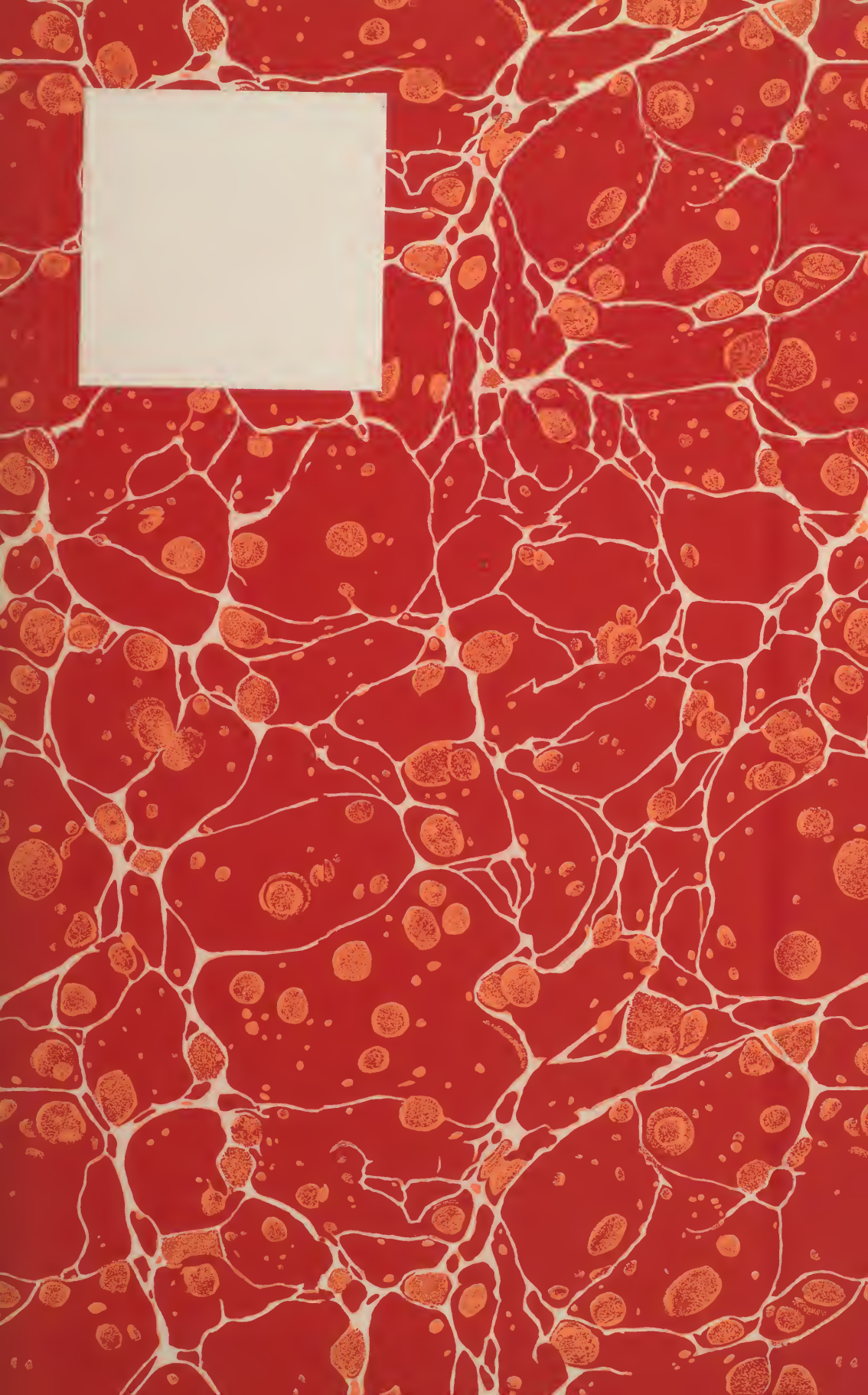
In order to search for the ligature, an inch of the posterior wall of the innominate was cut out, and several sections made by Mr. Abraham, but no trace of it could be found. The coats of the vessel were undivided.

The result of this case, although much to be regretted, clearly shows that the ligature had entirely succeeded, but that an abscess, resulting from imperfect healing of the wound, had opened into the innominate close to the bifurcation. No blood, however, had passed the point of deligation, nor had any descended the common carotid; the hemorrhage must, therefore, have been supplied by the vertebral.

The occurrence of an abscess, which, not having exit externally, burrowed deeply till the pus found its way into a vessel, is an accident hardly likely to recur. The fact that the vessels were closed on each side of the ligature by firm clot,¹ that the aneurism was far advanced in the process of cure, and, above all, that the coats of the vessel were, at the point of deligation, uninjured, vindicates, most completely, the principles which guided me in the choice of a flat ligature, viz., to leave the parietes of the vascular lumen intact and without breach of continuity. The fortuitous opening by an abscess into that lumen does not, in any way, affect or detract from that position. The case, though ending in death, proves even more conclusively than if it had been successful, the value of the ox-aorta ligature.

¹ That in the carotid had been subsequently softened by admixture with pus from without.





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